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OPERATIONS AND COSTS OF MANUFACTURING DAIRY PRODUCTS IN CALIFORNIA

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FOREWORD

This report, composed of two distinct parts, has been prepared primarily to provide descriptive information and essential cost data to supplement and support a companion study relating to problems of pricing milk for manufacturing purposes in California.[1]

An analysis of any segment or aspect of the dairy industry requires an understanding of the industry as a whole, its total manufacturing capacity, and its various plant operations. To satisfy this need, Part I of this report presents a description of the manufactured dairy products industry, together with a review of the results of a survey recently made of the equipment capacity of plants in the industry.

Any investigation of the factors which influence the pricing of milk for manufacturing purposes must be founded on a knowledge of the probable costs of processing whole milk into dairy products. Hence, Part II of this report has as its objective the development of an analysis of the processing costs involved in the manufacture of selected dairy products. The technique used in this analysis is known as the budgetary or synthetic model procedure used frequently in recent studies of this nature. The data furnished by the 1961 survey of the industry, supplemented by direct interviews with industry personnel, served as a basis both for the development of specifications for the "model" plants and for the estimation of comparative costs of processing milk into various manufactured dairy products. As indicated above, the cost estimates so developed have been used as an important element in a broader and more detailed investigation of the pricing mechanism for milk for manufacture in California.

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[1] D. A. Clarke, Jr., Olan D. Forker, and Aaron C. Johnson, Jr., "Pricing Milk for Manufacturing Purposes in California" (accepted for publication as a California Agricultural Experiment Station Bulletin).

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OPERATIONS AND COSTS OF MANUFACTURING DAIRY PRODUCTS IN CALIFORNIA

by

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PART I: A DESCRIPTION OF THE MANUFACTURED DAIRY PRODUCTS INDUSTRY IN CALIFORNIA

At the present time, approximately 40 percent of California's total commercial milk production is utilized in the manufacture of dairy products other than fluid market milk products. About one-half of this quantity is obtained from manufacturing milk, or Grade B dairies while the other half is supplied from market milk, or Grade A dairies. Among a wide variety of products manufactured by the industry, the most important are butter, nonfat dry milk, cottage cheese, evaporated milk, condensed skim milk, frozen dairy products (ice cream, ice milk, sherbet, imitation ice milk, and imitation ice sherbet), frozen dairy product mixes, and cheeses other than cottage cheese (including American, granular, Monterey, brick, Italian, and cream cheese).[4]

Number and Location of Plants

In 1962 a total of 200 plants in California were involved in the manufacture of one or more of these products. Of these plants, some specialized in a single dairy product, others were multiproduct plants manufacturing various combinations of dairy products, and still others produced manufactured dairy products merely as a sideline activity of a fluid milk operation.[1]

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[4] Other dairy products which make use of relatively small quantities of manufacturing milk include yogurt, whipped cream topping, sterilized milk products, whey, plastic cream, milk albumin, casein, and powdered milk.

The largest numerical concentrations of manufacturing plants are to be found in southern California (71 plants) and along the Central Coast (52 plants). In general, however, the San Joaquin Valley plants are considerably larger in size than those of the other areas. For example, as many as 25, or more than half, of the Valley plants used over 5,000 gallons of milk daily during 1962 while only 5 southern California plants used more than this volume. Some dairy product manufacturing plants are also located in the Sacramento Valley (13 plants) and in the North Coast area (5 plants). Only one plant is located in the Northeast area and none in the Sierra Mountain district. The number of plants located in each county in 1962 is shown in Table 1.

Products Manufactured

The plants located in the metropolitan areas of southern California and the Central Coast region are predominantly manufacturers of ice cream and other frozen dairy products and cottage cheese. Plants in the San Joaquin and Sacramento Valleys also manufacture these products, as well as butter, nonfat dry milk, and evaporated milk; while North Coast plants are primarily manufacturers of butter, nonfat dry milk, and frozen dairy product mixes. A distribution by districts of the number of plants manufacturing each product is presented in Table 2. This particular distribution, in terms of location, size, and type of product, occurs largely because most of the milk produced in or near metropolitan areas is utilized for fluid purposes; and manufacturing activities in these areas arise principally for the purpose of utilizing occasional surpluses of milk not needed for bottling. Facilities for processing ice cream and other frozen dairy products and for packaging cottage cheese are quite common in metropolitan areas.

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[1] For a more detailed discussion of the industry, including the incidence of multiproduct activity and trends in number, see O. D. Forker, "California's Manufactured Dairy Products Industry: Economic Adjustments of the Industry and of Six San Joaquin Valley Dairy Cooperatives" (accepted for publication as a California Agricultural Experiment Station Bulletin).

TABLE 1

Number of Dairy Product Manufacturing Plants, by Counties of Plant Location, California, 1962[a]

County and district	Total number of plants[b]
Del Norte	3
Humboldt	2
North Coast	5
Shasta	1
Siskiyou	4
North Central	5
Lassen	1
Northeast	1
Alameda	19
Contra Costa	1
Monterey	1
San Francisco	13
San Luis Obispo	3
San Mateo	1
Santa Clara	7
Sonoma	7
Central Coast	52
Butte	1
Glenn	3
Sacramento	6
Solano	2
Yolo	1
Sacramento Valley	13
Fresno	7
Kern	4
Kings	5
Madera	2
Merced	6
San Joaquin	8
Stanislaus	13
Tulare	8
San Joaquin Valley	53
Imperial	2
Los Angeles	50
Orange	3
Riverside	2
San Bernardino	4
San Diego	8
Santa Barbara	2
Southern California	71
State total	200

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[a] Data furnished by Dr. Howard Stover, Associate Research Technician, California Department of Agriculture.

[b] Includes plants manufacturing butter, nonfat dry milk, evaporated milk, condensed skim milk, cottage cheese, hard cheese, and frozen dairy products.

TABLE 2

Number of Plants Manufacturing Specific Manufactured Dairy Products, by Type of Product and by District, California, 1962

District	Total number of plants[a]	Type of product manufactured							Frozen products			
		Butter	Nonfat dry milk		Evaporated whole milk	Condensed skim milk	Uncreamed cottage cheese	Cheese[b]	Ice cream	Ice milk and sherbet	Imitation ice cream and ice milk	Frozen product mix[c]
			Spray process	Roller process								
North Coast	5	2	2	[d]				1				3
North Central	5	2				1	1		3	2	2	5
Northeast	1											1
Central Coast	52	6	3	2		4	4	7	33	10	8	15
Sacramento Valley	13	3	2	1	1	4	2		8	4	2	11
San Joaquin Valley	53	13	13		6	14	15	5	18	14	7	23
Southern California	71	6					13	5	41	30	11	51
Total	200	32	20	3	7	23	35	18	103	60	30	109

[a] The detail does not add up to the total plants because some plants manufacture more than one product.

[b] Other than cottage cheese.

[c] Ice cream, ice milk, and sherbet.

[d] Blanks indicate specific product was not manufactured.

The larger plants in the San Joaquin Valley and the Sacramento Valley are primarily manufacturing plants, but many of them also ship fluid market milk to the metropolitan areas to be bottled and distributed for fluid consumption. As previously stated, these plants constitute the major portion of the dairy manufacturing industry and are the basic examples used in Part II for the cost analysis of manufactured dairy products plants.

In 1962 the existing 200 plants in California had available for manufacturing 117 million pounds of milk fat and 3 billion pounds of skim milk. Quantities of milk fat and skim milk available for the manufacture of dairy products have been generally increasing since 1952. The trends in availability and utilization since 1950 are presented in Table 3.

The largest quantities of milk fat have been utilized for butter, ice cream, and evaporated milk; while nonfat dry milk, cottage cheese, and evaporated milk have been the most important utilizations for skim milk. During the past decade evaporated milk has steadily declined both in absolute and relative terms. Powdered (whole) milk utilization, relatively small in total, has also declined in recent years. Butter and nonfat dry milk production have been quite variable, but production of the various other products has been generally increasing over the time period considered.

In the aggregate, California is deficit in the production of all dairy products. For example, in 1962 nearly 60 percent of the total butter reported received at San Francisco originated from out-of-state sources.1/ Estimates based on United States per capita consumption rates and California production data indicate that California manufactures about one-fourth of the butter, one-eighth of the cheese, and three-fourths of the nonfat dry milk consumed in the state.

A Survey of Plant Operations

The conversion of milk into manufactured dairy products requires specialized equipment and facilities. The sizes and types of equipment on hand at a

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1/ California Federal-State Market News Service, Dairy and Poultry Market News: Annual Report of Origin of Receipts, San Francisco, 1961-62 (San Francisco, January 29, 1963) 2p.

TABLE 3

Estimated Utilization of Milk Fat and Skim Milk in Manufactured Dairy Products, California, 1950-1962

Year	Milk fat utilization								
	Total available	Butter	Evaporated milk	Condensed milk	Powdered milk	Cottage cheese	Ice cream	Ice milk and sherbet	Other
	thousand pounds								
1950	92,290	28,045	25,039	2,097	2,039	3,096	20,946	2,371	8,657
1951	86,624	17,695	25,500	1,778	2,197	3,305	22,121	2,360	11,668
1952	80,165	13,507	22,401	2,204	1,887	3,514	24,500	2,511	9,641
1953	94,699	23,070	23,186	2,088	1,737	3,647	24,690	3,046	13,235
1954	106,589	32,308	22,185	2,142	1,804	3,612	23,302	3,636	17,600
1955	105,323	27,167	22,950	2,678	1,578	3,845	24,283	3,939	18,883
1956	96,655	18,398	20,766	4,677	1,076	4,322	26,182	4,055	17,179
1957	103,048	25,556	21,270	3,976	652	4,462	27,944	4,064	15,124
1958	97,353	19,119	17,884	3,944	848	4,574	29,181	4,039	17,764
1959	104,333	23,860	18,879	3,662	673	4,795	30,125	4,109	18,230
1960	108,763	27,786	18,487	4,375	673	4,913	30,052	3,978	18,499
1961	115,390	31,873	16,986	4,911	501	4,803	30,467	3,975	22,083
1962	116,436	32,008	15,506	3,839	338	4,808	30,762	4,454	24,721

(Continued on next page.)

Table 3--continued.

Year	Skim milk utilization								
	Total available	Nonfat dry milk	Evaporated milk	Condensed milk	Condensed skim milk	Powdered milk	Cottage cheese	Buttermilk	Other
	thousand pounds								
1950	2,435,408	517,682	669,794	56,161	204,537	51,615	330,119	118,567	486,933
1951	2,254,312	271,557	682,138	47,750	212,031	55,616	367,956	124,727	492,537
1952	2,117,199	284,911	599,221	59,115	157,902	47,754	381,156	130,922	456,218
1953	2,534,381	623,700	620,228	56,084	184,944	43,974	382,794	128,624	494,033
1954	2,828,837	813,670	593,437	57,471	268,212	45,647	403,200	131,855	515,345
1955	2,802,964	764,566	613,901	71,716	177,693	39,937	418,162	139,337	577,652
1956	2,594,852	542,201	555,493	125,100	188,328	27,224	482,156	139,519	534,831
1957	2,752,464	704,330	568,979	106,388	257,343	16,516	495,738	142,482	460,688
1958	2,591,494	595,727	478,401	105,584	268,089	21,470	521,938	142,335	457,950
1959	2,824,604	745,899	505,023	97,901	290,538	17,029	535,600	139,640	492,974
1960	2,918,779	798,765	494,526	116,790	298,767	17,043	541,294	136,711	514,883
1961	3,069,176	904,954	454,375	131,102	303,661	12,692	538,294	132,579	594,330
1962	3,078,019	910,229	414,773	102,416	a/	8,564	539,339	129,414	

a/ Blanks indicate that comparable data are not available from published sources.

Sources:

1950-1960: Data provided by Dr. Howard Stover, Associate Research Technician, Bureau of Milk Stabilization, California Department of Agriculture. See Appendix A for utilization conversion factors.

1961-1962: Calculated from published data of the California Crop Reporting Service, particular time specify the upper limits of the quantity of milk that can be utilized by the industry and the quantity of each product that can be produced in any given time period. An even more important restraint upon plant size, however, is the amount of milk which it has available for manufacture. This is determined by many factors, such as local production density, the relative amount of Grade A milk available in excess of fluid requirements, and many others--all of which are beyond the scope of the present analysis.

Knowledge of the incidence and characteristics of the equipment in the industry should provide a better descriptive insight into the industry and an estimate of the industry's total manufacturing capacity. Such information is essential as a basis for the development of manufacturing cost studies. Consequently, a purposive survey of the industry was made in the fall of 1961 to determine the general type, size, and location of existing processing facilities.1/ A review of the data collected in the survey is presented here to provide further insight into the operation of the industry. The data have also been used as guidelines in the development of specifications for the model plants that are analyzed later in this report.

In a survey of the plant equipment and capacity of manufacturing plants in California, responses were obtained from 72 plants which used an aggregate average daily volume of milk of 7.7 million pounds. This represented 75 percent of the industry activity in May, 1961, when the average daily volume of milk available for manufacturing in the entire state was 10.3 million pounds. For each respondent plant, data were obtained relating to the type of equipment in operation at that time, the product output rate per hour or per batch, the normal daily hours of operation, and the number of hours required each day to clean and maintain the equipment.

In accordance with dairy manufacturing practices, certain pieces of equipment are essential to the manufacture of a particular product, as a butter churn is essential to the production of butter. On the other hand, certain pieces of equipment may be common to the manufacture of all products, such as a pasteurizer that is generally used for all milk received in a plant. In most instances, the manufacturing operation involves a flow process in which several

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1/ The survey was conducted by the Bureau of Milk Stabilization, California Department of Agriculture.

pieces of equipment operate sequentially and simultaneously, requiring that their rate of operation be synchronized. Efficient equipment utilization is an individual plant problem that is beyond the scope of this study. Normally, in the manufacture of each dairy product, a particular piece of equipment determines or specifies the rate at which the product can be produced.

The following summary description is limited to the pieces of equipment that are essential to the manufacture of specific products: butter churns, evaporators, dryers, cottage cheese vats, and homogenizers for ice cream mix processing.

Location of Plants Surveyed

The 72 plants that responded to the survey were largely located in the San Joaquin Valley, southern California, and in the Central Coast region. The predominant number of plants equipped with butter, evaporating, drying, and cottage cheese facilities were located in the San Joaquin Valley; while those equipped with facilities for cottage cheese packaging and for ice cream homogenizing were also represented in the metropolitan areas of the state--the Central Coast district and southern California. The geographical and numerical distributions of the plants surveyed, according to the type of equipment in use, are presented in Table 4.

Plant Equipment and Operating Capacities

Each respondent plant in the survey reported the various types of equipment on hand in the fall of 1961 and the rate at which each type of equipment was normally operated, either in terms of raw-product input or in terms of product output. When applied to a specific time period, each such operating rate can be translated into an estimate of plant operating capacity. The aggregate of these capacity estimates for all plants during any given time period can then be obtained by a summation of their individual operating capacities. A summary of equipment capacity, including the aggregate capacity for all reporting plants, for selected types of equipment, is shown in Table 5.

The evaporator, dryers, and homogenizers operate continuously at a specified rate, and operating capacities are therefore usually specified in terms of units of input per hour. For example, 28 plants reporting evaporators had the aggregate capacity to condense skim milk (all evaporators operating concurrently) at the rate of 503,750 pounds of skim milk per hour. The individual

TABLE 4

Number of Plants Reporting Specific Types of Dairy Equipment, by Districts, California, 1961

District	Total plants reporting	Type of equipment								
		Butter churns	Butter cutters and wrappers	Evapo-rators	Can fillers (evapo-rated milk)	Dryers		Ice cream mix homoge-nizers	Cottage cheese vats	Cottage cheese packaging equipment
						Spray process	Roller process			
North Coast	2	2	1	2	a/	2		1		
North Central	1			1				1	1	1
Northeast	0									
Central Coast	13	6	2	5		2	2	6	2	3
Sacramento Valley	6	3	1	4	9	2	1	5	1	1
San Joaquin Valley	29	10	2	16	5	11		7	16	8
Sierra Mountain	0									
Southern California	21	3						14	6	6
Total	72	24	6	28	6	17	3	34	26	19

a/ Blanks indicate that no equipment of this type was reported by plants surveyed.

TABLE 5

Summary of Equipment Capacity Survey, Selected Types of Equipment, 72 Reporting Plants
California, 1961

Butter churns (operating capacity per batch)	
Plants reporting	24
Aggregate capacity, all plants	50,420 pounds of milk fat per batch
Average capacity per plant	2,100 pounds of milk fat per batch
Range of plant capacities	324-5,670 pounds of milk fat per batch
Average time required to make one batch	2.58 hours
Evaporators (operating capacity per hour--3:1 ratio of input to output)	
Plants reporting	28
Aggregate capacity, all plants	503,750 pounds of skim milk per hour
Average capacity per plant	18,000 pounds of skim milk per hour
Range of plant capacities	3,000-60,000 pounds of skim milk per hour
Dryers, spray process (operating capacity per hour)	
Plants reporting	17
Aggregate capacity, all plants	312,000 pounds of skim milk per hour
Average capacity per plant	18,350 pounds of skim milk per hour
Range of plant capacities	4,400-40,700 pounds of skim milk per hour

(Continued on next page.)

TABLE 5--continued.

Dryers, roller process (operating capacity per hour)	
Plants reporting	3
Aggregate capacity, all plants	21,450 pounds of skim milk per hour
Average capacity per plant	7,150 pounds of skim milk per hour
Range of plant capacities	4,400-8,800 pounds of skim milk per hour
Cottage cheese vats (capacity per set)	
Plants reporting	26
Aggregate capacity, all plants	1,781,250 pounds of skim milk per set
Average capacity per plant	68,500 pounds of skim milk per set
Range of plant capacities	900-174,000 pounds of skim milk per set
Average time required to make one set	8.04 hours
Ice cream mix homogenizers (homogenizing capacity per hour)	
Plants reporting	34
Aggregate capacity, all plants	324,600 pounds of ice cream mix per hour (an equivalent of 175,300 pounds of milk fat)
Average capacity per plant	9,550 pounds of ice cream mix per hour
Range of plant capacities	1,000-27,600 pounds per hour

operating capacity of these plants ranged from 3,000 to 60,000 pounds of skim milk per hour, with an average capacity of 18,000 pounds per hour.[1]

Butter and cottage cheese production are batch processes and operating capacities are therefore generally expressed in terms of units of input or output per batch or per set. For example, the 24 plants reporting butter churns had an aggregate capacity of 50,420 pounds of milk fat per batch; that is, when all 24 churns were operated concurrently to make one full churning of butter, 50,420 pounds of milk fat (input) would be used to produce 62,251 pounds of butter. The average time required to make one batch was 2.58 hours. Similar operating rate specifications for other selected types of equipment are also presented in Table 5.

Among the plants surveyed, the largest equipment was reported by plants in the San Joaquin Valley. A comparison of the operating capacity rates of all reporting plants, by districts, indicated that those in the San Joaquin Valley had the following percentages of the aggregate capacity: butter churns, 48 percent; evaporators, 68 percent; dryers (spray process), 61 percent; cottage cheese vats, 83 percent; ice cream mix homogenizers, 29 percent. Roller process dryer capacity was entirely located in the Central Coast and Sacramento Valley areas. Ice cream mix homogenizer capacity was most important in southern California. The percentage distribution among the districts, by aggregate capacity and by type of equipment, is shown in Table 6.

Aggregate Annual Plant Capacity

The total quantity of products that dairy manufacturing plants can potentially produce annually is limited by the type and size of equipment; the total quantity actually produced during a year depends also upon the number of hours and days the equipment is used. This in turn depends upon the quantity of milk and the supply of labor available.

By making various assumptions regarding the hours and days of operation, it was possible to obtain an estimate of the total annual capacity of the facilities surveyed. The potential annual aggregate capacity for the 72 plants

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[1] Evaporator pans are also used to condense or evaporate whole milk and to condense milk in ratios other than 3 to 1. The input rate will vary with the amount of moisture that is removed. In evaporated milk plants the evaporators might be synchronized with the can fillers; thus the operating rate of the evaporators would be determined by the operating rate of the filler.

TABLE 6

Percentage Distribution of Dairy Manufacturing Capacity by Selected Types of Dairy Equipment, by Districts California, 1961

District	Type of equipment					
	Butter churns a/	Evaporators b/	Dryers		Cottage cheese vats e/	Ice cream mix homogenizers f/
			Spray process c/	Roller process d/		
	percent					
North Coast	12	13	23	g/		2
North Central		1			1	5
Northeast						
Central Coast	20	6	3	59	4	13
Sacramento Valley	12	12	13	41	5	9
San Joaquin Valley	48	68	61		83	29
Sierra Mountain						
Southern California	8				7	42
Total	100	100	100	100	100	100

a/ Aggregate capacity, 72 plants: 62,250 pounds of butter per batch.

b/ Aggregate capacity, 72 plants: 503,750 pounds of skim milk per hour.

c/ Aggregate capacity, 72 plants: 312,000 pounds of skim milk per hour.

d/ Aggregate capacity, 72 plants: 21,450 pounds of skim milk per hour.

e/ Aggregate capacity, 72 plants: 1,781,250 pounds of skim milk per set.

f/ Aggregate capacity, 72 plants: 324,600 pounds of ice cream mix per hour.

g/ Blanks indicate that no equipment of this type was reported by plants surveyed.

was developed separately under the following three alternative assumptions as to operating specifications:

Alternative I: Plant operation at six days per week with daily operating time specification at the average of the daily operating hours determined by the survey to be practicable under conditions existing in the fall of 1961.

Alternative II: Plant operation at six days per week with two eight-hour shifts per day and allowance for maintenance and cleanup time.

Alternative III: Plant operation at six days per week with three shifts per day, that is, continuous operation for six days with daily shut-down time allowance for maintenance and cleanup.

The potential annual capacities obtained under these three alternative assumptions are presented in Table 7. Implied in their calculation is the further assumption that labor and other inputs could be so organized as to permit operation at the rate and for the time period specified. For each alternative, the potential annual capacity of each type of equipment was calculated by applying the appropriate aggregate operating rate, as previously determined, to the specified hours of daily operation and number of days operated.

When the aggregate annual capacity estimates are compared with the total quantity of dairy products actually produced in 1961, the existence of excess capacity is indicated for all specified types of equipment under all three alternative conditions, with the exception of dryers under Alternative II. However, it must be noted that utilization at any given time might actually be equal to capacity on any one day in any one plant because of the seasonality of milk production and consumption and because of the day-to-day variations in the receipts and sales of the given plant.

The excess capacity percentages shown in Table 7 implicitly assume a uniform daily production level throughout the year. In reality, this is not the case. For example, the 112 percent excess capacity of dryers under Alternative I is an overestimate of the actual excess capacity for June, 1961. Nonfat dry milk production for that month was 10.8 million pounds, or an equivalent of 118.8 million pounds of skim milk. The aggregate dryer capacity for June under Alternative I would be 183 million pounds of skim milk, or a capacity 54 percent in excess of what was needed to produce nonfat dry milk during that particular month. Under Alternative III, however, the June capacity would be 155 million pounds, or only 30 percent in excess of needs. Capacity under Alternative II would be inadequate. Therefore, one can deduce that during June,

TABLE 7

Total Estimated Annual Productive Capacity of 72 Dairy Manufacturing Plants, Under Three Alternative Operating Assumptions, Compared with Actual Production Levels California, 1961

Equipment type	1961 production levels[a]	Productive capacity			Capacity as a percent of 1961 production		
		Alternative[b]			Alternative		
		I	II	III	I	II	III
	million pounds of milk fat				percent		
Butter churns	31.9	46.1	87.4	136.3	145	274	427
Ice cream mix homogenizers	34.4	60.5	76.6	127.6	176	223	371
	million pounds of skim milk						
Evaporators	1,806	2,257	1,984	3,240	125	110	179
Dryers[c]	1,034	2,197	1,025	1,856	212	99	179
Cottage cheese vats	532	817	839	1,417	154	158	266

a/ Includes milk fat or skim milk equivalents of all products for which this equipment would be used.

b/ Operation under all alternatives at 6 days per week (312 days annually) with allowances for cleanup and maintenance. Alternative I reflects the practicable hours of operation as determined by plant survey, with additional time allowance for cleanup. Alternative II operation is restricted to two 8-hour working shifts per day, including cleanup and maintenance time. Alternative III is for three 8-hour working shifts per day, including a daily time allowance for cleanup and maintenance. Exact daily operating time specifications are given in Appendix B.

c/ Includes both spray- and roller-process dryers.

1961, most of the available dryer equipment was operated nearly 24 hours a day, six days a week, with a reasonable daily time allowance for cleanup and maintenance. The survey response indicated that dryer facilities at times operated continuously in excess of 24 hours for a given operation. This would indicate substantial pressure on available capacity during certain days of the year.

Interplant Transfers of Milk

Among the plants surveyed, over one-half reported transfers of milk to other plants. Thirty-eight shipped skim milk, 12 shipped cream, and 26 shipped whole fluid milk. Most of these plants were located in the San Joaquin Valley, but several in southern California also diverted milk and milk components to other plants.

The number of plants receiving milk from other plants exceeded those that shipped milk. Fifty-five received skim milk from other plants, 36 received whole milk, and 21 received cream. Again, most of this interplant shipment activity took place in the San Joaquin Valley and southern California.

PART II: AN ANALYSIS OF COSTS OF PROCESSING MANUFACTURED DAIRY PRODUCTS

Scope and Procedure of Analysis

The principal objective of this section of the study was to determine the comparative costs involved in processing whole milk into alternative manufactured dairy products. This objective was derived from the need for input data for a companion study which analyzed pricing efficiency at the producer level.[1] For that analysis information was required on the relative production costs for alternative products in order to determine (a) the relative profitability involved in the manufacture of the alternative product combinations and (b) the extent to which California processors returned to producers the "net value" of the raw milk supplies received by them from California dairymen. The second of these objectives involved the detailed calculation of relative yields, product prices, and appropriate processing costs for the different alternatives.

The decision on objectives and procedure was largely based on the desire to obtain reasonable estimates of costs that would be incurred by firms operating their plants at efficient levels, each equipped and staffed to produce a specialized product or product combinations. For this purpose, 10 such specialized plants were selected. The decision to compute costs for specialized rather than diversified plants was made not because it was in any sense more "realistic" but because this procedure would eliminate the need for arbitrary allocation of "joint costs." It was believed that such a procedure would provide the best estimates of the production costs required for the pricing analysis. Since most plants are faced with a given milk supply, the raw milk intake at each plant was fixed at a constant quantity. The annual volume was specified on the basis of receipts at existing plants, and the monthly volume specifications were varied according to seasonal variation in California production. Input-output relations were determined by consulting with milk-plant engineers and other industry personnel. Since product yields vary with the fat and nonfat solids composition of milk receipts, specific yield computations were based on the average constituency of milk receipts for the period of time under analysis.

1/ Clarke, Forker, and Johnson, op. cit.

The products chosen for cost analysis include the major users of milk fat for manufacture in California--evaporated milk, cream, butter, and ice cream mix. With the exception of evaporated milk, all of these are produced in conjunction with the following skim-milk-containing products: nonfat dry milk solids, condensed skim milk, and cottage cheese. Therefore, the 10 combinations analyzed include cream-nonfat dry milk, cream-condensed skim milk, cream-cottage cheese, butter-nonfat dry milk, butter-condensed skim milk, butter-cottage cheese, ice cream mix-nonfat dry milk, ice cream mix-condensed skim milk, ice cream mix-cottage cheese, and evaporated milk. In the aggregate, these products accounted for approximately 80 percent of the utilization of milk for manufacture during 1962.

This study made use of the budgetary or synthetic model procedure which had been developed and applied by Bressler and other researchers. The analytical framework and development of procedure has been adequately treated in other studies and need not be repeated here.[1] Sometimes called the "building-block technique," this procedure was employed most recently to develop costs of processing manufactured dairy products in the New York milkshed.[2] By this technique, model plants are designed of specified capacity, equipment, and labor force, and their operating costs are then determined.[1] It is generally assumed that these model plants make use of the processing techniques, managerial practices, market organization, and institutional arrangements actually prevailing in the industry. Once such a plant has been designed and organized as an efficient and workable operation, money prices may be attached to the various input requirements in order to calculate total and unit costs.

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[1] R. G. Bressler, Economies of Scale in the Operation of Country Milk Plants with Special Reference to New England (Boston: New England Research Council on Marketing and Food Supply, 1942), 92p.; and M. C. Conner, Leland Spencer, and C. W. Pierce, Specifications and Costs for a Milk Pasteurizing and Bottling Plant, Virginia Agricultural Experiment Station Bulletin 463, Northeast Regional Publication 16 (Blacksburg, 1953), 48p. For a detailed discussion of both the theoretical basis for this technique and its adaption to cost analysis of plant operations, see B. C. French, L. L. Sammet, and R. G. Bressler, "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears," Hilgardia, Vol. XXIV, No. 19, July, 1956, pp. 544-591. To see how these techniques have been applied to problems of developing the costs of transportation services, see D. A. Clarke, Jr., A Cooperative Analysis of the Costs of Operating Milk Collection Routes by Can and by Tank in California, University of California, Giannini Foundation Mimeographed Report No. 91 (Berkeley, 1947), 46p.; and Idem, Milk Delivery Costs and Volume Pricing Procedures in California, California Agricultural Experiment Station Bul. 757 (Berkeley, 1956), 77p.

[2] T. R. Owens and D. A. Clarke, Jr., Class III Milk in the New York Milkshed: III. Costs of Manufacturing Dairy Products, U. S. Agricultural Marketing Service, Marketing Research Report No. 400, 1960, 57p.

This particular procedure was selected over the alternatives of the accounting or statistical approaches for two main reasons. First, there are such differences within the dairy industry in prices (of equipment, supplies, and other items), input rates, plant and labor efficiency, and managerial skills that little comparability in costs exists even among plants of the same general size and type. These differences greatly increase the difficulty of obtaining adequate estimates of costs for any type of plant and tend to make interplant and intra-industry comparisons less meaningful. The model plant technique attempts to overcome these problems by applying the same input standards and prices to all plants in the series to be studied. Second, the synthetic model technique lends itself with great facility to modification, adaptation, and revision. This quality enables the investigator to develop costs for a wide variety of products by modifying the basic model to conform to different sets of processing requirements. In addition, the results obtained can be applied to other areas or time periods involving different prices merely by changing the prices used to determine the various costs. For example, this study has drawn heavily upon input specifications and other data used in the previously mentioned New York studies, although necessary changes were made to adapt the model plants to conditions more commonly found in California.

The primary purpose of this cost analysis is to determine costs consistent with reasonably efficient operations in California. These levels of reasonable efficiency were determined for the model plant by the physical specifications developed for equipment, labor, and other inputs. It is recognized that this synthetic procedure reflects neither "average" processing costs for the market

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1/ This technique is also frequently used to develop cost information for similar plants of varying sizes and thus to determine "economies of scale" curves. This was not done in the present study since its purpose was to determine a single-valued cost figure for a plant of given size (specified by its annual intake of milk for manufacture) when alternative product combinations were produced.

nor costs for any particular plant or group of plants. It develops costs only for the model plant specified. However, the level of costs obtained by this technique should represent attainable levels under conditions of efficient organization. Moreover, the costs of processing any one of the alternative products and combinations determined by this method should tend to be consistent with the costs of the other products manufactured in plants with comparable levels and patterns of milk receipts.

Model Plant Specifications

In order to obtain processing cost estimates for the various products consistent with costs experienced by California plants, the model plant sizes were specified at a level near the median of plants that process the major portion of the manufactured dairy products in California. Based on the survey discussed earlier, this would be a size that could process, during the peak season, a volume of 325,000 pounds of milk daily.1/ To the extent that scale economies exist, larger plants would have lower per-unit costs and smaller plants higher per-unit costs than those costs obtained from model plants of this size. However, since this size does fall within the median range of the larger plants--those located in the San Joaquin Valley and those that utilize 75 percent of the milk available for manufacturing--the cost estimates that result, although probably not statistically representative of costs that actually exist in the industry, should represent relative cost levels attainable by plants manufacturing alternative product combinations when processing volumes of this magnitude and when efficiently organized.

Since average daily receipts of 325,000 pounds was accepted as the peak capacity and therefore specified the size of the plants analyzed, this was

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1/ In 1961, in the peak month of May, the 10 largest plants located in the San Joaquin Valley had available for manufacture an average of 384,900 pounds of milk per day. Of these 10 plants, the smallest handled approximately 230,000 pounds, while the largest handled over 800,000 pounds. The average of the two median plants was very close to the 325,000 pounds specified for the model plant.

the figure set for the month of May, the month during which the amount of milk available for manufacture in California is largest.[1/] To determine reasonable quantities available during each of the remaining months of the year, an index of seasonality of the availability of milk for manufacture was constructed based on historic data obtained through the records of the California Crop and Livestock Reporting Service. This monthly index was then applied to the May level of model plant receipts in order to determine the monthly variation in average volume received at the model plant. The results are shown in Table 8.

TABLE 8

Average Daily Receipts at Model Plants of Milk for Manufacture, California, 1961

Month	Average daily receipts
	pounds
January	199,632
February	199,380
March	264,834
April	299,574
May	325,000
June	310,903
July	311,910
August	282,959
September	229,086
October	205,926
November	194,346
December	196,863
Annual average daily volume	251,701
Total annual receipts	81,581,865

[1/] It should be noted that in California milk available for manufacture is derived from two sources. The first of these is that of manufacturing grade (or Grade B) milk which is not eligible for fluid or Class I uses. The second source is derived from Grade A milk production in excess of Class I requirements. In 1961, for example, slightly more than half of the total milk available for manufacture came from the latter source. To the extent that there is a substantial seasonal variation in the production of Grade A milk, and to the extent that the demand for milk for Class I purposes remains relatively stable throughout the year, the impact of these seasonal excesses of Grade A milk supply would tend to heighten the degree of seasonal variation in the total quantities of milk for manufacture in this state.

On the basis of these results, the model plants were specified to handle a total of approximately 82 million pounds of milk per year with an average daily volume slightly in excess of 250,000 pounds.

The cost estimates of the model plants were developed on the basis of the following cost elements: labor, utilities, building expenses, equipment expenses, consumable supplies, and packaging expenses.

Building Requirements

In general, floor space requirements were adopted from other studies and modified to meet more closely the conditions existing in California processing plants.[1/] Several of the manufacturing plants in the San Joaquin Valley were visited for the purpose of surveying the actual floor space requirements of specific processing centers.[2/] It was noted during this survey that substantial variations existed among plants in the amount of floor space allocated to each center. The allocation of total floor space is largely based on the experienced judgment of plant engineers and industry personnel. However, it is believed that the overall space requirements, as finally determined, are reasonably consistent with the efficient operation of a dairy products plant that manufactures and handles the various products chosen for analysis. The specific floor space requirements adopted for each of the 10 plants analyzed in this study appear in Table 9. The model plants were specified to be of concrete block exterior with the receiving section of the plant to be one story (approximately 8 feet) in height and the storage areas 30 feet in height. Processing areas involving the use of condensing equipment were also specified to be 30 feet high, but it was assumed that when a vacuum pan was not required (as in the butter-cottage cheese and cream-cottage cheese plants) a building height of one story was sufficient to house the necessary equipment.

[1/] C. N. Page and S. A. Walker, Building Designs for Dairy Processing Plants, Idaho Agricultural Experiment Station Bulletin 297 (Moscow, 1953), 27p.; Owens and Clarke, op. cit.; and J. N. Boles, "Economies of Scale for Evaporated Milk Plants in California," Hilgardia, Vol. XXVII, No. 21, October, 1958, pp. 621-722.

[2/] In this study, the term "center" refers to a specific phase of processing operations performed in a manufacturing plant. Several phases, sometimes called "stages," are common to all plants regardless of the final product manufactured. These include such operations as milk receiving, separating, and pasteurizing. Other stages or centers, such as butter churning and dry milk spray processing apply only to those plants which produce these finished products.

TABLE 9

Floor Space Requirements for Model Plants
by Type of Plant, California, 1961

Type of plant	Plant area
	square feet
Cream-nonfat dry milk	24,926
Cream-condensed skim milk	19,749
Cream-cottage cheese	22,688
Butter-nonfat dry milk	25,330
Butter-condensed skim milk	20,153
Butter-cottage cheese	23,092
Ice cream mix-nonfat dry milk	27,795
Ice cream mix-condensed skim milk	20,085
Ice cream mix-cottage cheese	23,024
Evaporated milk	22,000

Land Specifications

On the basis of plant surveys, data available from other studies, and information obtained through interviews with industry personnel, it was estimated that plants of the type considered here would require 65,000 square feet of land. It was concluded that this area would provide adequate space for the building, for service and access to the building, and for necessary parking facilities.

Equipment Specifications

The type, size, model, and capacity of the various kinds of equipment required by each dairy manufacturing plant under consideration were specified on the basis of the appropriate plant centers. As previously mentioned, each processing plant can be divided for analytical purposes into separate phases or centers. When appropriately assembled, these centers define a complete plant for the production of any specified product or product combination.1/ A total of 16 centers are considered in this study. They include the following:

1/ The specification of types of equipment, its estimated life, purchase price, and annual depreciation appear in Appendix C.

Processing Centers

Receiving
Separation
Cream pasteurizing
Raw cream sales
Condensed milk processing
Dry milk spray processing
Cottage cheese processing
Butter churning
Ice cream mix processing

Nonprocessing Centers

Utilities
General service equipment
Office equipment
Laboratory equipment
Piping
Main power
Personal convenience

The equipment requirements for the model plants were either adapted from other studies, developed from industry sources, or established independently on the basis of specifications supplied by equipment manufacturers. The equipment specifications so determined were then discussed with industry representatives and subsequently modified, if necessary, in order to conform more closely to actual conditions existing in California manufacturing plants. The general principle applied was to supply enough capacity to allow each kind of plant to process peak receipts of milk. For related pieces of operating equipment, every effort was made to specify capacities that would permit the product to move smoothly from each operation to the next. Specifications and requirements for steam boilers and refrigeration systems were developed separately to meet peak plant requirements for each system. Requirements for sanitary lines were estimated on the basis of the location of equipment in each plant.

Labor Requirements

Because milk receipts are characterized by seasonal variation, as indicated in Table 8, it was assumed that the plants involved would operate at peak capacity (that is, every day of the month) only in May and June of each year. During the remaining months, these plants would operate just a sufficient number of days to utilize existing capacity. To permit this type of operation, sufficient storage space was provided in the equipment specifications to "hold over" milk which is received on the nonmanufacturing days. The number of processing days, by months, are shown in Table 10. On the average, therefore, these model plants would operate approximately six days per week.

As a result of this variation in number of days of operation, the total number of employees also varies slightly from month to month. For purposes of analysis, the total labor force was broken down into three major categories: plant supervision, nonoperational labor, and operational labor. The first two

TABLE 10

Number of Processing Days for Model Plants
by Months, California, 1961

Month	Number of processing days
January	26.5
February	24
March	26.5
April	25.5
May	31
June	30
July	26.5
August	26.5
September	26
October	26.5
November	26
December	26.5
Total for year	321.5

groups are constant for all plants and do not vary monthly. It was specified that the supervision was carried on by one plant manager and one assistant plant manager. The nonoperational labor force consisted of 14 employees, classified as follows:

Clerical	3
Laboratory	3
Boiler room	3
Maintenance	2
Field man	1
Janitor and miscellaneous	2
Total	14

The operational labor force required to carry on the processing activities in the several plants was developed according to the various functional centers previously described. Total monthly operational labor requirements, by type of plant, are presented in Table 11.

It should be noted that, because of the nature of the evaporated milk operation, it was assumed that no variation would occur in the number of operational employees required by this plant. The constant operational labor force includes 2 men in the receiving stage plus 18 men in the evaporating processing stage, a total of 20.

TABLE 11

Daily Operational Labor Requirements for Model Plants, by Type of Plant, by Months, California, 1961

Month	Type of plant									
	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evaporated milk
	men required per day									
January	12	8	21	15	11	24	13	9	22	20
February	12	8	21	15	11	24	13	9	22	20
March	14	9	22	17	12	25	15	10	23	20
April	15	9	22	19	13	26	16	10	23	20
May	15	9	22	19	13	26	16	10	23	20
June	15	9	22	19	13	26	16	10	23	20
July	15	9	22	19	13	26	16	10	23	20
August	14	9	22	17	12	25	15	10	23	20
September	12	8	21	15	11	24	13	9	22	20
October	12	8	21	15	11	24	13	9	22	20
November	12	8	21	15	11	24	13	9	22	20
December	12	8	21	15	11	24	13	9	22	20

Utility Requirements

The principal utilities used in manufactured dairy products plants in California are electricity, water, and natural gas. Electricity is required to operate the motors used in each stage. Electricity is also required to operate refrigeration compressors used to cool milk and milk products at various stages. Water is used to clean equipment; to rinse away waste, especially in the evaporation stage; and to rinse butter. Natural gas is required to provide heat for the spray-drying stage and to produce the steam needed for heating dairy products and for pasteurization, drying, and cleaning.

Electricity.--The horsepower specifications which provided the basis for specifying the electricity requirements were determined, with the aid of plant personnel, for all of the motors operating at each stage. The proportion of time that each motor operated during the production process was similarly determined. The horsepower specifications were then converted to kilowatt-hours by use of a ratio of 1 kilowatt-hour of electrical energy consumed for each installed motor horsepower per hour of use. The total kilowatt-hours at each stage were then related to the rate of output to determine the per-unit requirement.

Electricity requirements for cooling were derived by direct inference from engineering data. One ton of refrigeration is defined in terms of the removal of heat at the rate of 12,000 Btu's per hour.[1] It is known that the power requirements of a mechanical refrigeration system are greatly affected by varying operating conditions. However, as an approximation, other writers have used a "rule of thumb" specification that 1 ton of refrigeration capacity requires the equivalent of 1 motor horsepower which, in turn, is roughly equivalent to an input of 1 kilowatt of electrical energy. This rule is considered to make adequate allowances for both motor and system inefficiencies. On this basis the cooling of 1 pound of milk through a temperature range of $(t_1 - t_2)$ degrees Fahrenheit utilizes electrical energy as determined by the formula: $KWH = \frac{(t_1 - t_2)}{12,000}$, where KWH represents the kilowatt-hour requirements for refrigeration; the notation, t_1, represents the starting temperature in degrees Fahrenheit; and t_2 represents the cooled temperature.[1] The total monthly electrical requirements in kilowatt-hours for each of the plants analyzed are shown in Table 12.

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[1] One Btu is the quantity of heat required to raise the tempreature of 1 pound of water 1 degree Fahrenheit.

Water.--Water requirements for each of the various stages of the model plants were developed independently with the application in each instance of a standard appropriate to the specific stage. For the most part, the quantities of water used for cleaning and rinsing butter and for making cottage cheese were estimated by plant personnel. The amount of water needed for operating the evaporator were developed on the basis of manufacturers' specifications. The estimated quantities of water used monthly by the several plants are presented in Table 13.

Natural Gas.--Estimates of the amounts of natural gas required for producing steam for pasteurizing and heating milk products were derived from engineering-type data. Under normal milk plant conditions, approximately 1,000 Btu's of heat are available per pound of steam. This relationship, previously adopted by Forker in an analysis of plant costs, was also accepted for this study.[2] Therefore, the relationship of 1/1,000 pound of steam requirement for each change of 1 degree in temperature per pound of product was used to determine steam requirements for each stage in processing.[3]

The steam required for the evaporation stage was determined from manufacturers' specifications. Steam requirements for cleaning were estimated by plant personnel.

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[1] The engineering basis for these relationships has been obtained from A. W. Farrall, Dairy Engineering (New York: John Wiley and Sons, Inc., 1953), 477p. The same relationships have been adopted by many other studies: see Forker, op. cit.

[2] Forker, op. cit.

[3] The formula that was applied for determining steam requirements was:

$$S = \frac{M(t_2 - t_1)}{1,000}$$

where S = the pounds of steam requirements, M refers to the pounds of product involved, and the element $(t_2 - t_1)$ refers to the number of degrees by which the temperature is raised.

TABLE 12

Monthly Electricity Requirements for Model Plants, by Type of Plant, California, 1961

Month	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evaporated milk
	kilowatt-hours									
January	149,986	114,851	65,084	154,018	118,879	69,112	130,759	106,836	61,722	44,377
February	135,955	104,088	58,920	139,532	107,640	62,472	119,082	96,978	55,992	41,249
March	199,524	152,640	86,364	204,569	157,961	91,415	175,277	142,532	82,022	62,172
April	217,385	166,234	93,993	222,768	171,615	99,374	191,473	155,467	89,493	64,403
May	286,721	219,232	123,938	293,787	226,300	131,006	252,658	205,104	117,866	86,437
June	265,571	203,040	114,750	272,084	209,564	121,274	234,257	190,037	109,204	83,196
July	235,345	179,935	101,707	241,110	185,699	107,471	207,566	168,426	96,839	74,963
August	213,305	163,134	92,246	218,634	168,469	97,582	187,693	152,501	87,779	68,245
September	169,229	129,506	88,894	173,606	133,878	93,266	148,338	120,778	69,666	61,412
October	154,887	118,561	67,151	158,981	122,649	71,239	135,350	110,388	63,751	53,413
November	143,281	109,746	62,218	147,128	113,588	66,060	124,934	102,002	58,991	45,214
December	147,833	113,234	64,210	151,542	117,233	68,208	128,988	105,191	60,848	43,879
Average per day[a/]	7,213	5,519	3,171	7,396	5,702	3,355	6,334	5,152	2,968	2,267
Total per year	2,319,022	1,774,201	1,019,475	2,377,759	1,833,205	1,078,479	2,036,375	1,656,240	954,173	728,960

Type of plant: all columns except Month.

a/ Based on 321.5 days per year.

TABLE 13

Monthly Water Requirements for Model Plants, by Type of Plant, California, 1961

Month	Type of plant									
	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evaporated milk
	pounds									
January	2,546,877	2,503,603	12,579,621	3,176,099	3,132,825	13,295,942	2,357,170	2,181,368	9,921,856	952,251
February	2,306,803	2,267,611	11,414,395	2,861,477	2,822,285	12,045,163	2,144,669	1,985,477	9,078,475	861,312
March	3,319,807	3,271,233	16,752,431	4,083,894	4,035,319	17,625,182	3,048,486	2,867,412	13,375,218	1,263,255
April	3,589,870	3,538,029	18,260,730	4,399,926	4,348,085	19,186,354	3,286,137	3,107,560	14,639,194	1,375,036
May	4,710,797	4,647,774	24,085,512	5,764,518	5,701,495	25,921,040	4,300,481	4,082,458	19,319,696	1,813,500
June	4,374,168	4,313,178	22,314,090	5,341,608	5,288,718	23,429,070	4,004,298	3,793,308	17,930,010	1,678,890
July	3,875,710	3,821,835	19,774,544	4,739,893	4,686,019	20,762,331	3,547,473	3,361,098	15,889,008	1,487,816
August	3,531,406	3,482,831	17,915,749	4,332,660	4,284,085	18,831,377	3,238,263	3,057,188	14,340,104	1,349,724
September	2,838,275	2,795,817	14,207,144	3,509,366	3,466,908	14,972,324	2,619,672	2,447,214	11,305,804	1,072,110
October	2,621,798	2,578,524	12,997,517	3,258,143	3,214,868	13,721,842	2,427,925	2,252,123	10,295,604	982,276
November	2,438,384	2,395,926	12,018,074	3,041,969	2,999,511	12,704,526	2,261,085	2,088,627	9,483,282	909,532
December	2,514,006	2,470,732	12,396,887	3,140,372	3,097,097	13,109,472	2,326,795	2,151,021	9,764,271	939,028
Average per day[a]	120,273	118,467	605,651	148,211	146,430	637,557	110,614	103,810	483,180	45,676
Total per year	38,667,901	38,087,093	194,716,694	47,649,925	47,077,215	204,974,623	35,562,454	33,374,854	155,342,522	14,684,730

a/ Based on 321.5 days per year.

A further specification used in computing natural gas requirements was that available natural gas contains 1,100 Btu's per pound. Assuming boiler operating rates at 70 percent efficiency, this will involve the use of 1.558 cubic feet of natural gas per pound of steam. The estimated monthly quantities of natural gas required by plants are presented in Table 14.

Development of Input Costs

As previously indicated, the money cost involved in the processing of manufactured dairy products is a function of the physical quantities of the inputs used and the prices which must be paid to obtain these productive factors. The purpose of this section is to discuss the procedures used in calculating these costs.

Investment in Land and Buildings

The relevant costs associated with investment in buildings include depreciation, interest, repairs and maintenance, taxes, and insurance. Those associated with land include interest on investment and taxes. Investment in the construction of the model plants, including the cost of land, was estimated at the rates of $14.00 per square foot and $9.75 per square foot, depending upon the type of plant and its construction.1/ The higher rate was applied to all plants which made use of a vacuum pan for condensing purposes, thus requiring a processing center with a 30-foot height. The lower rate was applied to all plants which did not require the vacuum pan--only the butter-cottage cheese and the cream-cottage cheese plants in this analysis. Based on 1961 cost rates, these figures were deemed appropriate. The cost of land required for a model plant was estimated at $15,000 per acre. This estimate was based on the value of a level lot adjacent to, but not within, an urban area. Each site to be used was assumed to have access to a hard-surface road and to city sewage and city water supplies. The summary of investment in buildings and land for the various types of plants analyzed appears in Table 15.

Depreciation.--In arriving at an estimate of annual depreciation for the building, the assumption was made that it would have an expected life of 40 years. On this basis, annual depreciation cost amounts to 2.5 percent of the

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1/ These cost-rates estimates were obtained from construction engineers and industry personnel.

TABLE 14

Monthly Natural Gas Requirements for Model Plants, by Type of Plant, California, 1961

Month	Type of plant									
	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evaporated milk
	cubic feet									
January	7,501,964	4,661,138	1,104,282	7,501,964	4,661,138	1,104,282	5,333,329	3,159,926	948,819	3,750,784
February	6,804,384	4,226,376	998,880	6,804,384	4,226,376	998,880	4,881,244	2,884,444	848,260	3,344,808
March	9,890,754	6,118,612	1,454,188	9,890,754	6,118,612	1,454,188	7,038,685	4,171,120	1,134,671	4,842,478
April	10,741,696	6,634,641	1,578,705	10,741,696	6,634,641	1,578,705	7,648,186	4,533,998	1,190,132	5,271,003
May	14,138,759	8,725,322	2,078,798	14,138,759	8,725,322	2,078,798	10,034,271	5,947,820	1,525,329	6,951,750
June	13,112,220	8,094,900	1,926,120	13,112,220	8,094,900	1,926,120	9,336,064	5,527,954	1,422,364	6,435,690
July	11,618,846	7,172,728	1,706,812	11,618,846	7,172,728	1,706,812	8,279,276	4,905,560	1,267,190	5,703,277
August	10,555,400	6,524,062	1,551,442	10,555,400	6,524,062	1,551,442	7,514,717	4,453,597	1,186,968	5,173,913
September	8,426,548	5,223,192	1,238,536	8,426,548	5,223,192	1,238,536	6,010,034	3,558,494	1,009,714	4,109,794
October	7,740,094	4,805,934	1,138,069	7,740,094	4,805,934	1,138,069	5,518,350	3,266,194	961,568	3,814,463
November	7,174,570	4,459,546	1,055,626	7,174,570	4,459,546	1,055,626	5,109,847	3,025,557	913,499	3,532,048
December	7,397,422	4,597,591	1,089,442	7,397,422	4,597,591	1,089,442	5,254,589	3,113,601	941,131	3,698,764
Average per day[a/]	358,018	221,599	52,631	358,018	221,599	52,631	254,926	151,005	41,523	176,139
Total per year	115,102,657	71,244,042	16,920,900	115,102,657	71,244,042	16,920,900	81,958,592	48,548,265	13,349,645	56,628,772

a/ Based on 321.5 days per year.

TABLE 15

Summary of Investment in Land and Buildings for Model Plants by Type of Plant, California, 1961

Type of plant	Investment
	dollars
Cream-nonfat dry milk	349,000
Cream-condensed skim milk	276,500
Cream-cottage cheese	222,300
Butter-nonfat dry milk	354,600
Butter-condensed skim milk	282,100
Butter-cottage cheese	225,800
Ice cream mix-nonfat dry milk	389,100
Ice cream mix-condensed skim milk	281,200
Ice cream mix-cottage cheese	322,300
Evaporated milk	308,000

total investment in the building. This is a figure commonly used for buildings of the type specified for the model plant. No effort was made in this analysis to separate depreciation due to obsolescence from depreciation due to physical wear of the building.

Interest.--Interest is a charge for the use of capital invested. As such, it is a cost of doing business and should be included in any analysis of plant costs. The magnitude of the charge is generally determined by the return this capital would bring in its best alternative use. This return may be represented by the going rate of interest. For the model plants, a rate of 5 percent of the average investment was selected. This rate was assumed to represent the expected returns from similar economic activity involving approximately the same element of risk. Since it was also assumed that the investment would decrease to zero at the end of the useful life of the asset, this rate was applied to one-half of the original amount of the investment.1/

Repairs and Maintenance.--Meaningful data on repair and maintenance costs for existing plants usually are not available. Expenditures vary according to the intensity of use, policies of individual firms toward maintenance, the original quality of the building or equipment, and other factors. Cost data obtained by California Bureau of Milk Stabilization personnel on expenses associated with fluid milk processing plants indicate that, on the average, expenditures made for repairs and maintenance are approximately of the same magnitude as allowances for depreciation. On this basis, therefore, annual expenditures for each of the plants considered are assumed to be equal to depreciation charges.

Taxes.--Property taxes are levied on the appraised value of the property as determined by the local assessor or other tax authority and are computed on the basis of a specified tax rate per dollar valuation. The appraised value may range from 10 to 100 percent of the actual value. Since both rates and assessed valuations vary from one community to another, the amount of taxes determined for the model plants does not pertain to any particular community.

1/ This can be stated in formula terms as follows:

$$I = \frac{A}{2}(i)\left(\frac{n + 1}{n}\right)$$

where I represents annual interest costs; A, the amount to be amortized; i, the interest rate; and n, the number of years of useful life of the building.

For application in this study, tax rates were obtained for the counties of Kern, Tulare, Kings, Fresno, Madera, and Merced. These rates ranged from \$5.50 to \$8.50 per \$100 evaluation on a 25 percent assessed valuation. In view of this range, a rate of \$6.25 per \$100 assessed valuation was selected as appropriate. At a 25 percent valuation, taxes amount to 1.625 percent of the total investment.

Insurance.--Risk of loss, resulting from damage or destruction of physical plant by any natural cause, or from changes in market conditions, or from any other causes, is a cost to the firm. Some of these risks (such as possible destruction of a physical plant) are insurable, so that the price of insurance, or premium, is a measure of the cost of risk bearing. The amount and kinds of insurance carried by a particular plant depend largely upon the attitude of the individual firm toward risk. In the model plants considered here, the insurance carried on the building was limited to fire insurance. Rates obtained from the Farmer's Insurance Group were used to determine fire insurance costs. For plants similar to the model plants, the applicable rate for fire insurance on buildings was \$1 per \$1,000 of total investment.

Annual Building Costs.--The separate building cost items were aggregated to obtain total annual building costs for each type of model plant. These are shown in Table 16.

Equipment Costs

The costs associated with the equipment involved in the model plants were developed by a method parallel to that used in specifying input requirements for equipment items. That is, both equipment specifications and costs were developed through the delineation of the 16 centers described earlier.[1]

Installed prices for each piece of equipment, as well as years of expected life, were obtained from industry sources. A major cost involved in installing equipment is that associated with the cost of electrical switchboards, panels, wiring, and other electrical costs associated with bringing power from the utility company's meter to the electrical consuming units. A procedure commonly used by the industry to account for this installation cost is to add 10 percent to the base cost of this equipment. For this reason, equipment investment in this analysis was increased by 10 percent of the initial investment in

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[1] Equipment specifications for all operating centers are given in Appendix C.

TABLE 16

Annual Building Costs for Model Plants, by Type of Plant California, 1961

Type of plant	Depreciation	Interest a/	Repairs and maintenance	Taxes a/	Fire insurance	Total
	dollars					
Cream-nonfat dry milk	8,725	9,499	8,725	5,671	349	32,969
Cream-condensed skim milk	6,912	7,618	6,912	4,493	276	26,211
Cream-cottage cheese	5,558	6,255	5,558	3,612	222	21,205
Butter-nonfat dry milk	8,865	9,643	8,865	5,762	355	33,490
Butter-condensed skim milk	7,052	7,764	7,052	4,584	282	26,734
Butter-cottage cheese	5,645	6,347	5,645	3,669	226	21,532
Ice cream mix-nonfat dry milk	9,728	10,573	9,728	6,323	389	36,741
Ice cream mix-condensed skim milk	7,030	7,741	7,030	4,570	281	26,652
Ice cream mix-cottage cheese	8,058	8,820	8,058	5,237	322	30,495
Evaporated milk	7,700	8,443	7,700	5,005	308	29,156

a/ Includes interest and taxes on land.

applicable centers to allow for the cost of this power hookup. The summary of investment in equipment, by type of plant, is given in Table 17.

The principal expenses associated with the investment in equipment include depreciation, interest, repairs and maintenance, taxes, and insurance. Depreciation was calculated by the "straight-line" method for each piece of equipment, based on its expected life. The total depreciation cost for each equipment center was then obtained by summing the costs for all the individual items of equipment in the center. The depreciation costs for all the appropriate centers comprising a plant were then accumulated to obtain the total depreciation cost for each plant. In general, annual depreciation costs ranged from 6.5 to 7.3 percent of the total investment in equipment. The interest charges associated with investment in equipment were calculated on the same basis previously described for interest on land and buildings. The principal variables involved in these calculations included the amount of the investment, the going rate of interest (again assumed to be 5 percent), and the expected life of the equipment.

As is true of building repair and maintenance expenses, these costs associated with equipment items are difficult to estimate. Therefore, for the reasons previously cited, these calculations were based on annual depreciation cost. For property taxes applicable to equipment, the rate previously selected for buildings was used--1.625 percent of the total investment. As before, insurance rates obtained from the Farmer's Insurance Group were used to determine fire insurance costs. The applicable rate for fire insurance on equipment in the model plants was $1.50 per $1,000 of total investment.

The separate components of equipment costs were summed to determine the total annual equipment costs for each type of plant. A summary of these costs is given in Table 18.

Labor Wage Rates and Costs

As previously discussed, labor requirements for manufacturing milk plants were divided into three major categories: supervisory, nonoperational, and operational labor. The supervisory personnel, consisting of one plant manager and one assistant manager, were assigned the monthly salaries typically paid such personnel. Including fringe benefits, these salaries were $850 and $725, respectively. The basic hourly wage rates for operational employees were

TABLE 17

Summary of Investment in Equipment for Model Plants, by Type of Plant
California, 1961[a]

Type of plant	Investment
	dollars
Cream-nonfat dry milk	605,870
Cream-condensed skim milk	507,570
Cream-cottage cheese	565,737
Butter-nonfat dry milk	617,947
Butter-condensed skim milk	519,582
Butter-cottage cheese	575,182
Ice cream mix-nonfat dry milk	659,670
Ice cream mix-condensed skim milk	552,082
Ice cream mix-cottage cheese	614,452
Evaporated milk	550,874

a/ From detailed list of investment for relevant centers contained in Appendix C.

TABLE 18

Annual Equipment Costs for Model Plants, by Type of Plant
California, 1961

Type of plant	Depreciation	Interest	Repairs and maintenance	Taxes	Fire insurance	Total
	dollars					
Cream-nonfat dry milk	41,828	16,190	41,828	9,845	909	110,600
Cream-condensed skim milk	34,181	13,541	34,181	8,248	762	90,913
Cream-cottage cheese	39,997	15,146	39,997	9,193	849	105,182
Butter-nonfat dry milk	41,231	16,486	41,231	10,042	927	109,917
Butter-condensed skim milk	33,700	13,833	33,700	8,443	780	90,456
Butter-cottage cheese	39,396	15,357	39,396	9,347	862	104,358
Ice cream mix-nonfat dry milk	47,996	17,694	47,996	10,720	990	125,396
Ice cream mix-condensed skim milk	39,875	14,794	39,875	8,971	828	104,343
Ice cream mix-cottage cheese	45,916	16,515	45,916	9,985	921	119,253
Evaporated milk	31,235	14,543	31,235	8,952	826	86,791

obtained from the labor contract, effective January 1, 1961, known as the Manufacturing Milk Products Agreement between Joint Council 38, consisting of locals affiliated with the International Brotherhood of Teamsters, Chauffeurs, Warehousemen, and Helpers of America, and the Milk Products Manufacturers Association of California. In general, four basic rate categories, which vary according to skill level, are applicable to this group. Basic hourly wage rates for the nonoperational labor were obtained in a similar fashion. All basic hourly rates appear in Table 19.

Total labor cost per plant worker included the basic hourly rate plus the following fringe benefits: welfare fund, \$11.75 per month; retirement fund, \$17.30 per month; uniform and laundry, \$0.65 per day; and social security payments, \$12.00 per month. In addition, provision was also made for unemployment compensation insurance, sick leave, and for paid vacation time.

As indicated previously, nonoperational labor personnel remains constant throughout the year, and it was assumed for purposes of this study that they would work, on the average, 22 days per month. As shown in Table 20, the total nonoperational labor cost per plant, including fringe benefits, amounts to slightly more than \$8,200 per month, or approximately \$375 per day.

As indicated earlier, labor input rates for the various operational or processing centers were obtained from industry sources and adapted to the specific operating requirements of the model plants. Work crews for each of these plants were then developed from the total estimated labor requirements for each of the stages in the individual plants. The relevant processing centers included in this discussion are: receiving, separating, pasteurizing, can filling (of both raw cream and ice cream mix), vacuum pan, or evaporating (including condensed milk processing), dry milk spray processing, butter churning, ice cream mix processing, and cottage cheese processing.

It was previously noted that, due to seasonal variation in receipts of milk available for manufacture, the model plants would operate a different number of days each month. Therefore, in some stages, the total work force is increased during the peak season months. In all, there were nine separate wage categories distinguished in these processing centers. These include:

1. Foreman
2. Relief
3. Bracket 1--regular
3a. Bracket 1--seasonal
3b. Bracket 1--night
3c. Bracket 1--night, seasonal
4. Bracket 2--regular
4a. Bracket 2--day, seasonal
4b. Bracket 2--night, regular

TABLE 19

Basic Hourly Wage Rates for Operational and Nonoperational Dairy Plant Employees, by Labor Category California, 1961

Labor category	Basic hourly wage rate
	dollars
Operational labor	
Working foreman	3.05
Relief men	2.98
Bracket 1 employees[a]	2.90
Bracket 2 employees[a]	2.78
Nonoperational labor	
Principal clerk	2.665
Senior clerk	2.405
Intermediate clerk	2.315
Laboratory personnel (bracket 1)	2.90
Laboratory personnel (bracket 2)	2.78
Boiler room personnel (bracket 1)	2.90
Maintenance personnel (bracket 1)	2.98
Field men (bracket 1)	2.90
General labor	2.45

[a] An additional 10 cents per hour is paid for night work between the hours of 6 p.m. and 6 a.m. Wage rates are the same for seasonal workers and regular employees.

Source: Manufacturing Milk Products Agreement between Joint Council 38, consisting of locals affiliated with the International Brotherhood of Teamsters, Chauffeurs, Warehousemen, and Helpers of America, and the Milk Products Manufacturers Association.

TABLE 20

Monthly Nonoperational Labor Costs for Model Plants, by Labor Category, California, 1961

Labor category	Wage rate per hour	Cost per day	Basic monthly wage cost[a]	Welfare	Retirement	Social security	Vacation and holidays[b]	Workmans' compen-sation[c]	Unemploy-ment com-pensation[d]	Sick leave[e]	Total for month
						dollars					
Clerical[f]											
1--Principal 1--Senior 1--Intermediate	2.46	59.04	1,298.88	35.25	51.90	36.00	113.16	1.56	36.00	24.60	1,597.35
Laboratory											
2--Bracket 1	2.90	46.40	1,020.80	23.50	34.60	24.00	88.93	1.22	18.00	19.33	1,230.38
1--Bracket 2	2.78	22.24	489.28	11.75	17.30	12.00	42.63	.59	9.00	9.27	591.82
Boiler room											
3--Bracket 1	2.90	69.60	1,531.20	35.25	51.90	36.00	133.90	30.62	27.00	29.00	1,874.87
Maintenance											
2--Skilled rate	2.98	47.68	1,048.96	23.50	34.60	24.00	91.39	20.98	18.00	19.87	1,281.30
Field man											
1--Bracket 1	2.90	23.20	510.40	11.75	17.30	12.00	44.47	.61	9.00	9.67	615.20
Janitor, miscellaneous											
2--General labor	2.45	39.20	862.40	23.50	34.60	24.00	75.13	1.03	18.00	16.33	1,054.99
Total average per day											374.81
Total per month											8,245.91

a/ On the basis of 22 days per month.

b/ Includes three weeks' vacation plus eight paid holidays, for a total of 186 hours per year.

c/ Computed at the rate of 0.12 percent of annual basic wage cost.

d/ Computed at the rate of 3 percent of first $3,600 earned per employee.

e/ On the basis of 40 hours per year.

f/ Hourly rate used represents an average of the following three clerical classifications: Principal, $2.665; Senior, $2.405; Intermediate, $2.314.

The summary of monthly operational labor costs, by type of plant, is presented in Table 21. All of these costs have been determined by applying the basic wage rates (given in Table 21), plus adjustments for fringe benefits, to the operational labor requirements presented in Table 12. Finally, all of the labor costs--supervisory, nonoperational, and operational--have been summarized for each of the model plants under consideration and are presented in Table 22.

Utility Costs

Cost rates for utilities were obtained from companies that normally provide service in the Central Valley. The Pacific Gas and Electric Company provides gas and electric service in this area, while local irrigation districts provide water not supplied from pumps owned by the processing plants.

Electricity.--Electricity service is priced in terms of the total quantity used during the month and the maximum rate at which it is used. Charges for electrical power therefore consist of two elements, the "energy" charge and the "maximum billing demand" charge. The energy charge is based on the amount of electricity used and is expressed as a cost per kilowatt-hour. Ordinarily, such cost rates are scheduled in decreasing increments, the last units being less costly than the initial unit. The second element, the maximum billing demand charge, is a monthly charge based on the maximum rate at which energy is required (peak load).

The maximum billing demand specifications for a model plant depend upon the rate at which electrical energy is consumed. The evaporated milk plant has the most electrical equipment and thus consumes electricity at the fastest rate. An earlier study made in California by Boles[1] indicated that a billing demand of 426 kilowatts was appropriate for an evaporated milk plant. Other studies suggested a 300-kilowatt specification for nonfat dry milk combinations and a 200-kilowatt specification for condensed-skim-milk combination plants. The former consumption rate is higher because of the greater number of electrical motors used in the drying process. The appropriate rates are given in Table 23.

These rates were then applied to the total monthly kilowatt-hour requirements already determined and presented in Table 12. The results are summarized in Table 24.

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[1] Boles, op. cit.

TABLE 21

Summary of Monthly Operational Labor Costs for Model Plants by Type of Plant, California, 1961

Month	Type of plant									
	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evaporated milk
	dollars									
January	9,090.91	6,066.49	15,629.39	11,343.34	8,318.92	17,881.82	9,841.72	6,817.30	16,380.20	14,692.52
February	8,353.77	5,574.51	14,361.18	10,423.86	7,644.60	16,431.27	9,043.80	6,264.54	15,051.21	13,500.89
March	10,522.89	6,782.48	16,292.81	12,775.32	9,034.91	18,545.24	11,273.70	7,533.29	17,043.62	14,692.52
April	10,868.71	6,560.60	15,762.26	13,718.27	9,410.16	18,611.82	11,595.21	7,287.10	16,488.76	14,215.87
May	12,905.04	7,781.14	18,680.85	16,289.48	11,165.58	22,065.29	13,765.26	8,641.36	19,541.07	16,837.45
June	12,534.81	7,559.23	18,150.14	15,822.01	10,846.43	21,437.34	13,370.72	8,395.14	18,986.05	16,360.80
July	11,238.88	6,782.48	16,292.81	14,185.68	9,729.28	19,239.61	11,989.69	7,533.29	17,043.62	14,692.52
August	10,522.89	6,782.48	16,292.81	12,775.32	9,034.91	18,545.24	11,273.70	7,533.29	17,043.62	14,692.52
September	8,943.47	5,968.09	15,375.70	11,159.42	8,184.04	17,591.65	9,682.12	6,706.74	16,114.35	14,454.19
October	9,090.91	6,066.49	15,629.39	11,343.34	8,318.92	17,881.82	9,841.72	6,817.30	16,380.20	14,692.52
November	8,943.47	5,968.09	15,375.70	11,159.42	8,184.04	17,591.65	9,682.12	6,706.74	16,114.35	14,454.19
December	9,090.91	6,066.49	15,629.39	11,343.34	8,318.92	17,881.82	9,841.72	6,817.30	16,380.20	14,692.52
Average per day[a]	379.80	242.48	601.78	473.84	336.52	695.82	408.09	270.77	630.07	553.59
Total per year	122,106.66	77,958.57	193,472.43	152,338.80	108,190.71	223,704.57	131,201.48	87,053.39	202,567.25	177,978.51

[a] Based on 321.5 days per year.

TABLE 22

Summary of Total Monthly Labor Costs for Model Plants, by Type of Plant, California, 1961

Month	Type of plant									
	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evaporated milk
	dollars									
January	18,911.82	15,887.40	25,450.30	21,164.25	18,139.83	27,702.73	19,662.63	16,638.21	26,201.11	25,048.69
February	18,174.68	15,395.42	24,182.09	20,244.77	17,465.51	26,252.18	18,864.71	16,085.45	24,872.12	23,553.16
March	20,343.80	16,603.39	26,113.72	22,596.23	18,855.82	28,366.15	21,094.61	17,354.20	26,864.53	25,048.69
April	20,689.62	16,381.51	25,583.17	23,539.18	19,231.07	28,432.73	21,416.12	17,108.01	26,309.67	24,450.49
May	22,725.95	17,602.05	28,501.76	26,110.39	20,986.49	31,886.20	23,586.17	18,462.27	29,361.98	27,740.67
June	22,355.72	17,380.14	27,971.05	25,642.92	20,667.34	31,258.25	23,191.63	18,216.05	28,806.96	27,142.47
July	21,059.79	16,603.39	26,113.72	24,006.59	19,550.19	29,060.53	21,810.60	17,354.20	26,864.53	25,048.69
August	20,343.80	16,603.39	26,113.72	22,596.23	18,855.82	28,366.15	21,094.61	17,354.20	26,864.53	25,048.69
September	18,764.38	15,789.00	25,196.61	20,980.33	18,004.95	27,412.56	19,503.03	16,527.65	25,935.26	24,749.56
October	18,911.82	15,887.40	25,450.30	21,164.25	18,139.83	27,702.73	19,662.63	16,638.21	26,201.11	25,048.69
November	18,764.38	15,789.00	25,196.61	20,980.33	18,004.95	27,412.56	19,503.03	16,527.65	25,935.26	24,749.56
December	18,911.82	15,887.40	25,450.30	21,164.25	18,139.83	27,702.73	19,662.63	16,638.21	26,201.11	25,048.69
Total per year	239,957.58	195,809.49	311,323.35	270,189.72	226,041.63	341,555.49	249,052.40	204,904.31	320,418.17	302,678.05

TABLE 23

Electricity Rates for Selected Billing Demand Specifications California, 1961

Kilowatt hours per month	Dollars per kilowatt
For 300-kilowatt maximum billing demand:[a]	
First 6,000 kilowatt hours	.0264
Next 15,000	.0222
Next 45,000	.0128
Next 30,000	.0091
Excess over 96,000	.0065
For 200-kilowatt maximum billing demand:[b]	
First 6,000	.0264
Next 10,000	.0222
Next 30,000	.0128
Next 20,000	.0091
Excess over 66,000	.0065
For 426-kilowatt maximum billing demand:[c]	
First 6,000	.0264
Next 21,300	.0222
Next 63,900	.0128
Next 42,600	.0091
Excess over 133,800	.0065

a/ Applicable to nonfat dry milk plants.

b/ Applicable to condensed skim milk and cottage cheese plants.

c/ Applicable to evaporated milk plants.

Source: Pacific Gas and Electric Company Schedule A-13, Revised California Public Utilities Commission Sheet No. 2854-E, effective November 15, 1957.

TABLE 24

Monthly Utility Costs: Electricity, Model Plants, by Type of Plant, California, 1961

Month	Type of plant									
	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evapo-rated milk
	dollars									
January	1,691.40	1,264.90	937.30	1,717.40	1,290.90	965.90	1,567.90	1,212.90	910.00	845.02
February	1,600.40	1,193.40	882.70	1,626.40	1,219.40	910.00	1,489.90	1,147.90	855.40	806.62
March	2,016.40	1,511.90	1,076.40	2,048.90	1,544.40	1,108.90	1,853.90	1,446.90	1,050.40	1,075.42
April	2,126.90	1,596.40	1,128.40	2,165.90	1,635.40	1,160.90	1,957.90	1,524.90	1,095.90	1,101.02
May	2,581.90	1,940.90	1,323.40	2,627.40	1,986.40	1,368.90	2,360.90	1,849.90	1,284.40	1,382.62
June	2,445.40	1,836.90	1,264.90	2,484.40	1,882.40	1,303.90	2,237.40	1,752.40	1,225.90	1,344.22
July	2,243.90	1,687.40	1,180.40	2,282.90	1,726.40	1,212.90	2,068.40	1,609.40	1,147.90	1,241.82
August	2,100.90	1,576.90	1,115.40	2,139.90	1,609.40	1,154.40	1,938.40	1,511.90	1,089.40	1,152.22
September	1,814.90	1,362.40	1,095.90	1,847.40	1,388.40	1,121.90	1,678.40	1,303.90	972.40	1,062.62
October	1,723.90	1,290.90	952.90	1,749.90	1,316.90	978.90	1,593.90	1,232.40	928.20	960.22
November	1,645.90	1,232.40	910.00	1,671.90	1,258.40	946.79	1,528.90	1,180.40	882.70	856.54
December	1,678.40	1,251.90	928.20	1,704.40	1,277.90	959.40	1,554.90	1,199.90	900.90	845.02
Average per day[a]	73.62	55.20	39.80	74.86	56.41	41.04	67.90	52.79	38.39	39.42
Total per year	23,670.30	17,746.30	12,795.90	24,066.80	18,136.30	13,192.79	21,830.80	16,972.80	12,343.50	12,673.36

[a] Based on 321.5 days per year.

Gas.--Natural gas is also supplied by the Pacific Gas and Electric Company to most processing plants in California. Its unit cost depends upon the quantity used per month. Most plants use "interruptible" service because it is cheaper, although it requires a standby oil-burning system that can be used if the gas company exercises its right to shut off service during peak demand seasons.[1] Since most plants use this service, the interruptible gas schedule has been accepted as appropriate. The rates used are given in Table 25.

TABLE 25

Natural Gas Rates for Interruptible Service
California, 1961

Usage million cubic feet	Rate cents per million cubic feet
First 1,000	56.5
Next 2,000	52.2
Next 3,000	50.5
Next 4,000	49.0
Over 10,000	42.6

Source: Pacific Gas and Electric Company Schedule No. G-50, Interruptible Natural Gas Service, effective August 25, 1960, Column A-1,100, Btu.

These rates were applied to the natural gas requirements presented in Table 14 and the results, by months, appear in Table 26.

Water.--At many plants, water is obtained from owned wells. The cost of water at any one plant depends upon the depth of its well and the size and efficiency of its pump. Since these factors generally vary greatly from plant to plant, it was decided to use a constant cost per unit of water based on actual charges for water in the San Joaquin Valley which industry sources indicated would be approximately 1 cent per thousand pounds of water. This

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[1] Interruptible service prescribes that the utility company may shut off gas service during peak demand periods at its discretion. However, in practice this rarely occurs. Provision of the oil-burning system is an additional cost and is included in equipment investment. However, since the fuel-oil system is rarely used, costs are developed on the basis of gas inputs only.

TABLE 26

Monthly Utility Costs: Natural Gas, Model Plants, by Type of Plant, California, 1961

Month	Type of plant									
	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evaporated milk
	dollars									
January	3,859.98	2,447.80	619.29	3,859.98	2,447.80	619.29	2,787.16	1,689.80	565.00	1,988.26
February	3,517.96	2,228.13	565.00	3,517.96	2,228.13	565.00	2,558.90	1,548.45	565.00	1,783.22
March	5,030.59	3,182.31	801.99	5,030.59	3,182.31	801.99	3,633.11	2,200.36	635.47	2,539.21
April	5,400.09	3,435.15	867.24	5,400.09	3,435.15	867.24	3,931.52	2,383.67	664.18	2,755.86
May	6,847.21	4,459.25	1,128.24	6,847.21	4,459.25	1,128.24	5,098.48	3,097.74	839.05	3,590.48
June	6,409.71	4,150.55	1,048.37	6,409.71	4,150.55	1,048.37	4,758.64	2,885.64	785.28	3,337.64
July	5,773.69	3,698.77	934.05	5,773.69	3,698.77	934.05	4,240.71	2,571.53	704.37	2,974.02
August	5,320.43	3,380.76	852.62	5,320.43	3,380.76	852.62	3,866.35	2,343.27	662.61	2,706.87
September	4,313.23	2,731.62	689.76	4,313.23	2,731.62	689.76	3,128.90	1,890.79	570.22	2,169.55
October	3,976.60	2,521.03	637.04	3,976.60	2,521.03	637.04	2,880.59	1,743.33	565.00	2,020.07
November	3,699.75	2,346.30	594.23	3,699.75	2,346.30	594.23	2,674.55	1,622.13	565.00	1,877.66
December	3,808.53	2,415.99	611.46	3,808.53	2,415.99	611.46	2,747.78	1,666.57	565.00	1,962.00
Average per day[a]	180.27	115.08	29.08	180.27	115.08	29.08	131.59	79.76	23.91	92.39
Total per year	57,957.77	36,997.66	9,349.29	57,957.77	36,997.66	9,349.29	42,306.60	25,643.28	7,686.18	29,704.84

a/ Based on 321.5 days per year.

rate was applied to the water requirements specified in Table 13 and the results appear in Table 27.

As a final step, the total utility costs for all of the model plants were aggregated and are shown in Table 28.

Other Costs

Packaging Costs.--Separate estimates of packaging costs were calculated only for butter, nonfat dry milk, and evaporated milk. The cost of cans used to package cream were considered to be a part of the equipment investment and was, therefore, included in the equipment costs involved. Cream packaging costs (investment in cans) are treated as an integral part of the depreciation cost of the equipment.

The packaging costs used for butter and nonfat dry milk were .3 cents and 1.05 cents per pound of product, respectively. These cost rates had been used in the New York study and were considered to be representative of California supply costs.[1] Estimates of evaporated milk packaging costs were obtained from industry sources and were set at $1.35 per case. This figure includes the cost of the fiber case, labels, label paste and glue, glue for sealing the case, and the cans used. Total monthly packaging costs by type of plant are presented in Table 29.

Consumable Supplies.--Consumable supplies include office, laboratory, and cleaning agents. The quantities required of these various supplies and the total cost estimates were obtained either from industry or from published sources. Office supplies were specified at 8 cents per 1,000 pounds of milk received, for an annual cost of $6,527 for each type of plant. Laboratory supplies were specified at 4½ cents per 1,000 pounds of milk received, for an annual cost of $3,674 for each type of plant. Cleaning supplies for all plants except the evaporated milk plant were specified at 5 cents per 1,000 pounds of milk received, a figure derived from the New York study, for an annual cost of $4,079. For the evaporating plant, the cost of supplies was specified at 12 cents per 1,000 pounds of milk received, a figure taken from the Boles study, for an annual cost of $9,790.

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[1] Owens and Clarke, op. cit., p. 34.

TABLE 27

Monthly Utility Costs: Water, Model Plants, by Type of Plant, California, 1961

Month	Type of plant									
	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evaporated milk
	dollars									
January	25.47	25.04	125.80	31.76	31.33	132.96	23.57	21.81	99.22	9.52
February	23.07	22.68	114.14	28.61	28.22	120.43	21.45	19.85	90.78	8.61
March	33.20	32.71	167.52	40.84	40.35	176.25	30.48	28.67	133.75	12.63
April	35.90	35.38	182.61	44.00	43.48	191.86	32.86	31.08	146.39	13.75
May	47.11	46.48	240.86	57.65	57.01	252.91	43.00	40.82	193.20	18.14
June	43.74	43.13	223.14	53.42	52.89	234.29	40.04	37.93	179.30	16.79
July	38.76	38.22	197.75	47.40	46.86	207.62	35.47	33.61	158.89	14.88
August	35.31	34.83	179.16	43.33	42.84	188.31	32.38	30.57	143.40	13.50
September	28.38	27.96	142.07	35.09	34.67	149.72	26.20	24.47	113.06	10.72
October	26.22	25.79	129.98	32.58	32.15	137.22	24.28	22.52	102.96	9.82
November	24.38	23.96	120.18	30.42	30.00	127.05	22.61	20.89	94.83	9.10
December	25.14	24.71	123.97	31.40	30.97	131.09	23.27	21.51	97.64	9.39
Average per day[a]	1.20	1.18	6.06	1.48	1.46	6.38	1.11	1.04	4.83	.46
Total per year	386.68	380.89	1,947.18	476.50	470.77	2,049.73	355.61	333.73	1,553.42	146.85

a/ Based on 321.5 days per year.

TABLE 28

Total Monthly Utility Costs, Model Plants, by Type of Plant, California, 1961[a]

Month	Type of plant									
	Cream-nonfat dry milk	Cream-condensed skim milk	Cream-cottage cheese	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Ice cream mix-condensed skim milk	Ice cream mix-cottage cheese	Evaporated milk
	dollars									
January	5,576.65	3,737.74	1,682.39	5,609.14	3,770.03	1,718.15	4,378.63	2,924.51	1,574.22	2,842.80
February	5,141.43	3,444.21	1,561.84	5,172.97	3,475.75	1,595.45	4,070.25	2,716.20	1,511.18	2,598.45
March	7,080.19	4,726.92	2,045.91	7,120.33	4,767.06	2,087.14	5,517.49	3,675.93	1,819.62	3,627.26
April	7,562.89	5,066.93	2,178.25	7,609.99	5,114.03	2,220.00	5,922.28	3,939.65	1,906.47	3,870.63
May	9,476.22	6,446.63	2,692.50	9,532.26	6,502.66	2,750.05	7,502.38	4,988.46	2,316.65	4,991.24
June	8,898.85	6,030.58	2,536.41	8,947.53	6,085.84	2,586.56	7,036.08	4,675.97	2,190.48	4,698.65
July	8,056.35	5,424.39	2,312.20	8,103.99	5,472.03	2,354.57	6,344.58	4,214.54	2,011.16	4,230.72
August	7,456.64	4,992.49	2,147.18	7,503.66	5,033.00	2,195.33	5,837.13	3,885.74	1,895.41	3,872.59
September	6,156.51	4,121.98	1,927.73	6,195.72	4,154.69	1,961.38	4,833.50	3,219.16	1,655.68	3,242.89
October	5,726.72	3,837.72	1,719.92	5,759.08	3,870.08	1,753.16	4,498.77	2,998.25	1,596.16	2,990.11
November	5,370.03	3,602.66	1,624.41	5,402.07	3,634.70	1,668.07	4,226.06	2,823.42	1,542.53	2,743.30
December	5,512.07	3,692.60	1,663.63	5,544.33	3,724.86	1,701.95	4,325.95	2,887.98	1,563.54	2,816.41
Average per day[b]	255.10	171.46	74.94	256.61	172.95	76.49	200.60	133.59	67.13	132.27
Total per year	82,014.75	55,124.85	24,092.37	82,501.07	55,604.73	24,591.81	64,493.10	42,949.81	21,583.10	42,525.05

a/ Includes electricity, natural gas, and water.

b/ Based on 321.5 days per year.

TABLE 29

Monthly Packaging Costs for Model Plants by Type of Plant, California, 1961[a]

Month	Type of plant					
	Cream-nonfat dry milk	Butter-nonfat dry milk	Butter-condensed skim milk	Butter-cottage cheese	Ice cream mix-nonfat dry milk	Evaporated milk
	dollars					
January	4,673.77	5,452.55	778.78	660.70	3,051.23	79,099.00
February	4,189.32	4,844.36	655.04	549.24	2,827.72	71,215.00
March	6,103.01	7,009.61	906.60	752.27	4,222.44	103,999.00
April	6,601.36	7,534.79	933.43	766.59	4,669.08	112,845.00
May	8,701.02	9,924.53	1,223.51	1,003.77	6,168.47	148,735.00
June	8,044.33	9,163.30	1,118.97	915.83	5,729.17	137,578.00
July	7,127.11	8,115.76	988.65	808.38	5,081.50	121,921.00
August	6,479.75	7,395.98	916.23	752.47	4,583.07	110,902.00
September	5,179.60	5,949.03	769.43	638.45	3,583.57	88,487.00
October	4,776.44	5,521.49	745.05	624.39	3,227.65	81,352.00
November	4,447.19	5,168.76	721.57	609.09	2,945.17	75,535.00
December	4,608.94	5,376.92	767.98	651.53	3,008.91	78,061.00
Total	70,931.84	81,457.08	10,525.24	8,732.71	49,097.98	1,209,731.00

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a/ Packaging costs were calculated only for nonfat dry milk, butter, and evaporated milk. Cans used for packaging other products were treated as part of equipment investment.

Insurance.--In this study, three types of insurance have been included: boiler liability insurance, comprehensive liability insurance covering injuries to employees, and product liability insurance. The annual boiler insurance premium for each model plant was determined to be $150. Comprehensive liability insurance was calculated at the rate of 15 cents per $100 of payroll, and product liability insurance at the rate of 7 cents per $1,000 of annual sales. The total annual costs of liability insurance are shown in Table 30, together with the annual costs for laboratory supplies, office supplies, and cleaning supplies, as well as the aggregate cost of these elements for each type of plant.

Summary of Total and Unit Processing Costs

Annual processing costs for each type of plant have been summarized by cost category and are shown in Table 31. Total yearly processing expenses at the model plants varied from a low of approximately $383,000 for the cream-condensed skim milk plant to a high of $1,692,000 for the evaporated milk plant. Also shown in Table 31, annual processing costs have been further broken down into costs per operating day and cost per hundredweight of milk received.

TABLE 30

Summary of Total Annual Costs of Consumable Supplies and Liability Insurance for Model Plants, by Type of Plant, California, 1961

Type of plant	Laboratory supplies	Office supplies	Cleaning supplies	Insurance[a]	Total
	dollars per year				
Cream-nonfat dry milk	3,674	6,527	4,079	1,031	15,311
Cream-condensed skim milk	3,674	6,527	4,079	964	15,244
Cream-cottage cheese	3,674	6,527	4,079	1,240	15,520
Butter-nonfat dry milk	3,674	6,527	4,079	782	15,062
Butter-condensed skim milk	3,674	6,527	4,079	715	14,995
Butter-cottage cheese	3,674	6,527	4,079	991	15,271
Ice cream mix-nonfat dry milk	3,674	6,527	4,079	1,110	15,390
Ice cream mix-condensed skim milk	3,674	6,527	4,079	1,042	15,322
Ice cream mix-cottage cheese	3,674	6,527	4,079	1,319	15,599
Evaporated milk	3,674	6,527	9,790	906	20,897

[a] Includes product liability, comprehensive liability, and boiler liability insurance.

TABLE 31

Total Processing Costs for Model Plants, Per Year, Per Operating Day, and Per Hundredweight of Milk Received by Cost Categories and by Type of Plant, California, 1961

Type of plant	Labor	Utilities	Building	Equipment	Consumable supplies and insurance	Packaging	Total	Per operating day[a]	Per hundred-weight received[b]
	dollars per year							dollars	
Cream-nonfat dry milk	239,958	82,015	32,969	110,600	15,311	70,932	551,785	1,716.28	.677
Cream-condensed skim milk	195,809	55,125	26,211	90,913	15,244	c/	383,302	1,192.23	.470
Cream-cottage cheese	311,323	24,092	21,205	105,182	15,520		477,322	1,484.67	.585
Butter-nonfat dry milk	270,190	82,501	33,490	109,917	15,062	81,457	592,617	1,843.29	.726
Butter-condensed skim milk	226,042	55,605	26,734	90,456	14,995	10,525	424,357	1,319.93	.520
Butter-cottage cheese	341,555	24,592	21,532	104,358	15,271	8,733	516,041	1,605.10	.633
Ice cream mix-nonfat dry milk	249,052	64,493	36,741	125,396	15,390	49,098	540,170	1,680.16	.662
Ice cream mix-condensed skim milk	204,904	42,950	26,652	104,343	15,322		394,171	1,226.04	.484
Ice cream mix-cottage cheese	320,418	21,583	30,495	119,253	15,599		507,348	1,578.06	.622
Evaporated milk	302,678	42,525	29,156	86,791	20,897	1,209,731	1,691,778	5,262.13	2.074

a/ Based on an average of 321.5 operating days per year.

b/ Based on total annual receipts of 815,819 hundredweight.

c/ Packaging costs were calculated only for nonfat dry milk, butter, and evaporated milk. Cans used for packaging other products were treated as part of equipment investment.

APPENDIX A

Utilization Conversion Factors[1]

The utilization factors used to convert product quantities to the milk-fat and skim-milk equivalents presented in Table 3 in the text are as follows:

Butter: 81 percent milk fat.

Evaporated milk: 8 percent milk fat, 2.14 pounds of skim per pound of product.

Condensed milk (unsweetened, bulk): 8.9 percent milk fat, 2.38 pounds of skim milk per pound of product.

Condensed milk (sweetened, case): 8.6 percent milk fat, 2.29 pounds of skim milk per pound of product.

Condensed milk (sweetened, bulk): 7.9 percent milk fat, 2.3 pounds of skim milk per pound of product.

Powdered milk: 29 percent milk fat, 7.34 pounds of skim milk per pound of product.

Condensed skim (unsweetened, bulk): 3 pounds of skim milk per pound of product.

Condensed skim (sweetened, bulk): 3 pounds of skim milk per pound of product.

Nonfat dry milk: 11 pounds of skim milk per pound of product.

Cottage cheese curd: 6.25 pounds of skim milk per pound of product.

Creamed cottage cheese: 4 percent milk fat.

Partially-creamed cottage cheese: 2 percent milk fat.

Buttermilk: 8.64 pounds of skim milk per gallon.

Ice cream: 0.54 pounds of milk fat per gallon.

Ice milk: 0.18 pounds of milk fat per gallon.

Sherbet: 0.09 pounds of milk fat per gallon.

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[1] Provided by H. J. Stover, Associate Research Technician, California Department of Agriculture.

APPENDIX B

Daily Operating Time Specifications, by Type of Equipment
California, 1961

Equipment type	Operating time		
	Alternative		
	I	II	III
	hours per day		
Butter churn	7.55	14.34	22.34
Ice cream mix homogenizers	9.48	12.00	20.00
Evaporators	14.36	12.62	20.62
Dryers[a]	21.12	9.84	17.84
Cottage cheese vats	8.04	12.60	20.60

a/ Includes both spray- and roller-process dryers. The survey indicated that in practice in Alternative I the dryer is not stopped and cleaned every 17.84 hours, but is often operated continuously in excess of 24 hours. Thus, Alternative I capacity is greater than Alternative III, which limits daily operation to 17.84 hours.

APPENDIX C

Cream-Nonfat Dry Milk
Equipment Specifications by Processing Centers[a]

Equipment: item and description	Estimated life	1961 purchase price	Annual depreciation
	years	dollars	
Can and bulk receiving center			
Can conveyors, complete, with drives, units, and turns	15	6,710	447
Weighing tank, two compartments, 750-pound stainless steel	12	1,000	83
Drop tank, 2,000-pound, two conductor-spout openings, stainless steel	20	1,500	75
Scale, 1,000-pound	15	1,200	80
Milk pump, 5-h.p., centrifugal, 60,000 pounds per hour at 40-foot head	14	840	60
Can washer, 6 C.P.M., rustproofed	14	5,500	393
DeLaval clarifier	15	850	57
Sample cooler, 240-Majonnier-bottle-capacity, $\frac{1}{4}$-h.p. compressor	15	1,021	60
Air compressor, 3/4-h.p. motor plus ceramic filter	14	250	18
Surge tank, 2,000-pound, stainless steel	20	1,450	72
Storage tanks, 6,000-gallon (5), stainless steel interior with agitator, diameter 96" x 190" long, zinc metallized finish ($8,222.00 each)	20	41,000	2,050
Scale mountings, I-beam frame and floor scales for weighing tank trucks (2)	20	9,800	475
Fin cooler, 60,000 pounds per hour	10	7,000	700
Facilities for cleaning bulk delivery units--portable washer	10	2,600	260
		80,721	4,830

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a/ For convenience, the complete list of equipment specifications are shown only for the cream-nonfat dry milk plant. Necessary equipment changes required to analyze the alternative plant costs are indicated under "Plant Modification." This will enable the reader to see what alterations are required in equipment centers for the alternative plants.

Equipment: item and description	Estimated life	1961 purchase price	Annual depreciation
	years	dollars	
Separation center			
Positive milk pump, 44,000 pounds per hour, 7½ variable speed	10	2,000	200
Plate heat changer, 44,000 pounds per hour, complete with hot water circulating unit and air controls	10	7,000	700
Separators (3), 11,000 pounds per hour, white enamel finish; with magnetic starter, accessories, and spare parts	10	40,000	4,000
Spare separator motor	10	2,000	200
		51,000	5,100
Cream pasteurizing center			
H.T.S.T. system, complete with holding tube, regeneration positive pump, surge tank, controls, air compressor, 6,000 pounds per hour	15	7,800	520
Cream storage tanks:			
1,000 gallons (3)	20	5,800	290
1,500 gallons (1)	20	2,500	125
		16,100	935
Raw cream sales center[a]			
Cream cans (1,208), 10-gallons each	6.3	13,300	2,111
Platform scale, 125-pound capacity	15	500	33
Conveyor, gravity, from city can room to cooler	15	700	47
Can truck	5	50	10
		14,550	2,201

[a] It was assumed that cream cans would be washed in can washer in receiving room.

Equipment: item and description	Estimated life	1961 purchase price	Annual depreciation
	years	dollars	
Condensed milk processing center			
Skim-milk storage tanks			
5,000 gallons, insulated (2)	20	12,600	630
6,000 gallons, insulated (2)	20	15,800	790
Skim-milk pump with 1-h.p., 3-phase motor	14	700	50
Vacuum pan, double effect, capacity: 15,000 pounds per hour, including inter-stage preheater and thermal compression	20	60,000	3,000
Hot wells (2)	20	3,300	165
Steam preheater	15	6,000	400
Condensed-milk storage tank, 1,000 pounds	20	1,400	70
		99,800	5,105
Dry milk spray processing center			
Drier (spray), including high-pressure pump (1,400 pounds per hour), 3,000-pound-per-hour tube heater, powder cooler, Y-bagger	15	90,000	6,000
Platform scales (2)	15	750	50
Barrel carts (2)	12	300	25
Pallet lift, hydraulic	12	600	50
Pallets (400)	10	1,400	140
Sack sewer, including hand machine for standby	15	2,200	145
Warehouse truck	5	7,000	1,400
		102,250	7,810

Equipment: item and description	Estimated life	1961 purchase price	Annual depreciation
	years	dollars	
Utilities center			
Steam			
Boilers (2), 250-h.p., with condensation pump, boiler controls, and gas and oil feed, including an oil storage tank for standby	20	50,000	2,500
Standby facilities for direct-feed gas dryer	20	4,000	200
Refrigeration			
Compressor, coldroom, 10-h.p., freon system	20	6,500	325
Compressors (2), sweet water, 20-h.p.	20	8,000	400
Sweet water systems (2), 12,500-pound ice builder	20	18,000	900
Cooling tower, 400 tons	10	12,000	1,200
Evaporative condenser, 40 tons	10	4,500	450
		103,000	5,975

Equipment: item and description	Estimated life[a]	1961 purchase price	Annual depreciation
	years	dollars	
General service equipment center			
Shop equipment	10	5,000	500
Portable electric drill			
Bench vise			
Acetylene torch			
Electric welder			
Anvil			
Air compressor			
Tube and die set			
Pipe threader			
Paint sprayer			
Pipe reamer			
Small electric grinder			
Large electric grinder			
Wheelbarrow			
Small tools			
Drill press			
Reseating tools			
Wood table saw			
Metal table saw			
Chain hoist			
Spare equipment	10	3,650	365
Positive milk pump			
Regular milk pumps (3)			
Positive milk pump head			
Motors (4), 3 h.p.			
Motors (2), 5 h.p.			
Motor, 10 h.p.			
		8,650	865

[a] Represents the average life of all the service equipment included.

Equipment: item and description	Estimated life[a]	1961 purchase price[b]	Annual depreciation
	years	dollars	
Office equipment center			
Office equipment	20	28,850	1,442
Billing machine			
Calculators (4)			
Adding machines (6)			
Desks and tables (10)			
Chairs (14)			
Typewriters (4)			
Safe			
Time clock			
Filing cabinets (8)			
Lighting and miscellaneous			
Storage cabinets (15)			
Cash register			
Postal scale			
Check protector			
Record binders (9)			
Stencil machine			
Addressing machine			
Water cooler			
Intercommunication system			
Posting trays (2)			
Check writer			

[a] Represents the average life of all the office equipment included.

[b] Investment estimated at 5 percent of total equipment investment in all other centers.

Equipment: item and description	Estimated life	1961 purchase price	Annual depreciation
	years	dollars	
Laboratory equipment center			
Laboratory equipment	20[a]	15,000	750
Majonnier tester Centrifuges (2), capacity: 36 bottles each Methylene blue set Electric water heater Acidity tester Sediment guns (4) Torsion balance scales (2) Hotplate Salt titration set Acid dispenser Trays and hot water bath Glassware Bottle washer Sterilizer Incubator Miscellaneous Storage cooler (household refrigerator)			
Piping center			
All piping and accessories	10	35,000	3,500
Main power center			
Installation of electrical switchboards, panels, wiring, and power hookup		45,250[b]	2,715[c]
Personal convenience center			
General equipment	10[d]	6,000	600
Lockers (40) Benches (6) Chairs and sofas (2) Medicine chests (2)			

[a] Represents the average life of all the laboratory equipment included.

[b] Investment estimated at 10 percent of total equipment investment in all centers having motor equipment.

[c] Estimated at 6 percent of investment.

[d] Represents the average life of all the equipment included.

Plant Modifications[1]

Cream-Condensed Skim Milk

1. Eliminate dry milk spray processing center.
2. Modify condensed skim milk processing center.
    a. Replace 1,000-gallon tank with:
        (1) one 6,000-gallon storage tank on scales.
        (2) one 3,000-gallon storage tank on scales.
    b. Add can filler valve.
    c. Add condensed milk cooler, capacity: 4,261 pounds per hour.

Cream-Cottage Cheese

1. Eliminate condensed skim milk processing center.
2. Eliminate dry milk spray processing center.
3. Add cottage cheese processing center (see schedule of items, p. 68).
4. Alter utilities center.
    a. Steam.
        (1) Eliminate two 250-h.p. boilers.
        (2) Add one 200-h.p. boiler.
    b. Refrigeration.
        (1) Replace one 10-h.p. compressor, cold room, with one 20-h.p. compressor, cold room.
        (2) Add one 20-h.p. compressor, sweet-water system.
        (3) Add one sweet-water system, 15,750-pound ice builder.
        (4) Eliminate cooling tower.

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[1] Equipment changes required in processing centers for alternative plants.

Cottage Cheese Processing Center

Item and description	Estimated life	1961 purchase price	Annual depreciation
	years	dollars	
Skim milk storage tanks (4), 6,000 gallons each, insulated	20	33,000	1,650
Skim pump, 1-h.p., 3-phase	14	100	7
Cheese vats (21), 10,000 pounds each, complete with hot water circulating units, sanitators, paddles, motors, and mounts	20	71,400	3,570
Starter cans (200)	10	2,200	220
Pasteurizing vats for starter manufacture (3), 500 gallons each	20	18,000	900
H.T.S.T. system for skim pasteurizing, 40,000 pounds per hour	15	19,300	1,287
Cottage cheese cans (2,172), 100 pounds each	6.3	23,900	3,794
		167,900	11,428

Butter-Nonfat Dry Milk

1. Eliminate raw cream sales center.
2. Add butter churning center (see schedule of items, p. 70).

Butter-Condensed Skim Milk

1. Eliminate raw cream sales center.
2. Eliminate dry milk spray processing center.
3. Modify condensed skim milk center.
    - a. Replace one 1,000-gallon tank with one 6,000-gallon condensed milk storage tank on scales.
    - b. Add can filler valve.
    - c. Add condensed milk cooler.
4. Modify utilities center.
    - a. Add one compressor, sweet water, 20 h.p.
    - b. Add one sweet-water system, 15,750-pound ice builder.
5. Add butter churning center (see schedule of items, p. 70).
6. Modify cream pasteurizing center: Replace four cream storage tanks with two larger tanks mounted on scales.

Butter-Cottage Cheese

1. Eliminate raw cream sales center.
2. Eliminate condensed skim milk processing center.
3. Eliminate dry milk spray processing center.
4. Add butter churning center (see schedule of items, p. 70).
5. Modify utilities center.
    - a. Steam: Eliminate one boiler, 250-h.p.
    - b. Refrigeration:
        - (1) Replace one 10-h.p. compressor, cold room, with one 20-h.p. compressor, cold room.
        - (2) Add one 20-h.p. compressor, sweet-water system.
        - (3) Add one sweet-water system, 15,750-pound ice builder.
        - (4) Eliminate cooling tower.

Butter Churning Center

Item and description	Estimated life	1961 purchase price	Annual depreciation
	years	dollars	
Churns (2), 2,000-pound capacity aluminum alloy, with $7\frac{1}{2}$-h.p. motor, 12'5" x 5'	15	20,200	1,335
BM surge tank (1), stainless steel, single shell, 300-gallon capacity	20	1,000	50
BM pump (1), $\frac{1}{4}$-h.p. centrifugal	14	50	4
BM pump (1), $\frac{1}{2}$-h.p. centrifugal	14	70	5
Accessories	15	2,384	159
Laboratory scales Hot plate Dial platform scales (1), 75 pounds by 1-ounce graduations Butter tools Loading conveyor			
		23,704	1,553

Ice Cream Mix-Nonfat Dry Milk

1. Eliminate cream pasteurizing center.
2. Eliminate raw cream sales center.
3. Add ice cream mix processing center (see schedule of items, p. 72).
4. Modify utilities center: Eliminate one 10-h.p. compressor, cold room.

Ice Cream Mix-Condensed Skim Milk

1. Eliminate cream pasteurizing center.
2. Eliminate raw cream sales center.
3. Eliminate dry milk spray processing center.
4. Add ice cream mix processing center (see schedule of items, p. 72).
5. Modify utilities center:
    a. Steam: Replace two 250-h.p. boilers with two 175-h.p. boilers
    b. Refrigeration:
        (1) Eliminate one 10-h.p. compressor, cold room.
        (2) Add one 20-h.p. compressor, sweet-water system.
        (3) Add one sweet-water system, 15,750-pound ice builder.

Ice Cream Mix-Cottage Cheese

1. Eliminate pasteurizing center.
2. Eliminate raw cream sales center.
3. Eliminate condensed skim milk center.
4. Eliminate dry milk spray processing center.
5. Add ice cream mix processing center (see schedule of items, p. 72).
6. Add cottage cheese processing center (see schedule of items, p. 72).
7. Modify utilities center:
    a. Steam: Replace two 250-h.p. boilers with two 200-h.p. boilers.
    b. Refrigeration:
        (1) Eliminate one 10-h.p. compressor, cold room.
        (2) Add one 20-h.p. sweet-water system compressor.
        (3) Add one sweet-water system, 15,750-pound ice builder.

Ice Cream Mix Processing Center

Item and description	Estimated life	1961 purchase price	Annual depreciation
	years	dollars	
Homogenizer, 20 h.p., 80 gallons per hour	15	5,500	367
Skim storage tanks (2), 6,000-gallon stainless steel, insulated	20	16,500	825
Plate coolers (2), 5,400 pounds per hour	10	2,900	290
Vats for mixing and pasteurizing (3), 600-gallon capacity	20	13,500	675
Mix cans (4,000)	6.3	44,000	6,984
		82,400	9,141